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USSR: Electronics & Electrical Engineering

FBIS 50th Anniversary Note

To Our Consumers:

This year the Foreign Broadcast Information Service observes its 50th anniversary.

The service, first called the Foreign Broadcast Monitoring Service, was established in 1941 prior to the U.S. entry into World War II. At the time, a number of U.S. Government officials were concerned about the content of foreign radio broadcasts—a relatively new means of conveying information and propaganda across borders. On their advice, President Franklin D. Roosevelt in late February 1941 allotted money from his emergency fund to institute the recording, translating, transcribing, and analyzing of selected foreign broadcasts for the U.S. Government. During World War II the service demonstrated that monitoring was a fast, economical, and reliable way to follow overseas developments.

Today the Foreign Broadcast Information Service provides its consumers throughout the federal government, according to their diverse official interests, with information from a broad range of foreign public media. FBIS information also is available to readers outside of the government, through the National Technical Information Service. Objectivity, accuracy, and timeliness are our production watchwords.

We members of the current staff of FBIS extend our thanks to consumers for their interest in FBIS products. To past staffers we extend our thanks for helping the service reach this anniversary year. At the same time, we pledge our continued commitment to providing a useful information service.

R. W. Manners
Director
Foreign Broadcast Information Service

Science & Technology
USSR: Electronics & Electrical Engineering

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UDC 621.372.001

Computer-Aided Physical Modeling and Design of VLSI Matrix Circuit Topology

917K0064A Moscow MIKROELEKTRONIKA in Russian Vol 19 No 6, Nov-Dec 90 pp 531-541

[Article by Yu. A. Mamatov and A. V. Kuznetsov, Institute of Computer Engineering Problems, USSR Academy of Sciences, Yaroslavl]

[Abstract] A hierarchical straight-through computer-aided design system using the IBM PC for design of MaVLSI (very-large-scale-integrated matrix) circuits has been developed at the Institute of Computer Engineering, this system consisting of four autonomous modules interacting through a common database. These modules are graphic display (GD) with sophisticated string editor (SEDIT) and NET programs, LOF logic-function modeling and MISS information storage management module, GALS automatic and HICAD interactive symbolic topology design module, and SOLARIS physical circuit modeling module. The database reads output data into a Kulon(COULOMB)-4, module where they are stored in SOURCE format on magnetic tape. The structure of the SOLARIS module, not only for physical modeling and design of real basic elements and modular blocks of MaVLSI circuits but also for comprehensive checkout of the topology, must satisfy three requirements related to interaction with the other modules. Firstly, it must be able to design and check out the topology of the logic base topology on a chip. Secondly, it must be able to model topological fragments such as macroblocks at both analog and digital levels. Thirdly and lastly, it must be able to analyze circuits taking into account parasitic effects. A need for new libraries on chips arises in at least three situations, one of them being transfer to a new chip and another one being transfer to a new chip architecture such as a C^2MOS architecture. The third one is development of parametrized library elements. The development of such an element proceeds in two steps: first is devised a procedure for describing the topology of such an element in the upper-level language with the aid of a silicon assembler and the topology of that element is then built according to this procedure to specifications extracted from the library. The procedure is demonstrated on modeling of metal-oxide semiconductor (MOS) transistors and complimentary metal-oxide semiconductor (CMOS) transistor pairs, on Meyer and various other models. With the topology laid out, it remains necessary to calculate resistances and capacitances along the routes. The algorithm for calculating capacitances in circuits with metallized (aluminumized) components is simple. Resistances can be calculated either by known heuristic methods or by solution of the two-dimensional Laplace equation for appropriate boundary conditions. The first way is rather primitive. The second way requires subdividing the channel between any two windows into triangular and rectangular segments depending on its configuration. The total resistance of such a channel is then calculated according to the rules of series and parallel networks. Circuital equations for computer-aided impedance calculations can be set up in any of the four now known schemes: 1) one-graph tabular, 2) two-graph tabular, 3) modified nodal, 4) two-graph modified nodal. The last scheme leads to a more compact matrix and allows matrix thinning to be ignored, use of a current I-graph and a voltage V-graph being particularly convenient for design analysis of circuits with switched capacitors on the basis of Kirchhoff's branch and node laws. Two important factors a computer-aided design of circuits with semiconductor elements must take into account are self-heating of these devices when they carry heavy currents and changes in their electrical properties as a result of either such a self-heating or change in the ambient temperature. Figures 4; references 9.

UDC 681.3.07.62-192

Calculations for Predicting Reliability of LSI Redundant Memories

917K0064B Moscow MIKROELEKTRONIKA in Russian Vol 19 No 6, Nov-Dec 90 pp 542-548

[Article by P. P. Urbanovich, Minsk Institute of Radio Engineering]

[Abstract] The reliability problem in designing LSI redundant memories is tackled, the problem calling for an iterative solution on account of the corrective code being selected on the basis of predicted LSI memory reliability but the reliability then being lower than predicted because of the additional hardware and correspondingly larger active chip area needed for implementation of that code. The problem is tackled by first determining the rates of various types of failure on chips, assuming that a failure flux is a statistically independent one with a Poisson distribution characterized by the parameter λt (λ- relative increment of rate of catastrophic failures owing to increase of active chip area, t- operating time) and that the failure rate on chips is proportional to their active areas and thus correspondingly higher on one with redundancy. The reliability of LSI redundant memories is then calculated as the probability of failure-free operation, the model of a storage structure being a square matrix tentatively subdivided into $(Nb)^{1/2}/k$ substorages consisting of $(Nb^{1/2}$ rows and columns each (N- number of storage information words, b- number of bits per storage information word, k- number of bits in information part of code word). This model and the algorithm of reliability calculation are, for illustration, applied to a 16 kbit chip with Nb = 4096x4 and k = 32 corresponding to four information words per row of storage. The probability of failure-free operation as a function of the operating time up to 10^8 h is evaluated for two redundant memories with $\lambda = 10^{-4}$ h^{-1} and $\lambda = 10^{-7}$ h^{-1} respectively, also for two nonreduntant memories with correspondingly m = 4 and m = 8 times smaller active areas. Figures 2; references 10.

UDC 621.382

Processes in Nanosecond Exposure of X-Ray Resists

917K0064C Moscow MIKROELEKTRONIKA in Russian Vol 19 No 6, Nov-Dec 90 pp 555-563

[Article by Yu. A. Kukharenko and Yu. S. Leonov]

[Abstract] An experimental study of exposure of X-ray resists to laser radiation was made, exposure of nanosecond duration being most desirable for X-ray lithography inasmuch as it yields a high concentration of low-energy electronic excitations and thus results in maximum possible precision. The experiment was performed with a laser-plasma X-ray source consisting a neodymium laser and a lead target. Plasma was generated by focusing second-harmonic laser radiation on the surface of the heavy lead target under vacuum within a spot with a diameter of about 30 μm, in pulses of 10-30 J energy and 2 ns duration, the diameter of the plasma glow region reaching about 100 μm. Conventional masks, windows in 0.45 μm thick gold layers on negative-resist silicon or polyimide membranes, were used for exposure doses of 0.05-0.1 J/cm^2. Stencil masks on 0.5 μm thick positive-resist PMMA-MAA (polymethyl methacrylate + methacrylic acid) membranes were used for exposure doses of about 0.1 J/cm^2 in single pulses. The exposure characteristics of both polymers and of silicon were measured in terms of average spectral exposure distribution $\delta P/\delta e = [(\delta I/\delta e)/R^2](1\ sr)$ J/(cm^2.keV) (ε- energy of absorbed photons, R- distance from target to mask on membrane). The data are evaluated for an analysis of the exposure process and attendant error sources, the total exposure error being the geometric sum of the treatment error and the mask error. The temperature stability of these masks is calculated on the basis of exposure dynamics and, in the specific case of nanosecond exposure, is found to extend over areas with linear dimensions of the order of 0.1 μm. A theoretical model of the exposure and photon absorption process is constructed demonstrating that formation of plasmons at inhomogeneities in a mask lowers the energy of photoelectrons generated in it and shortens their mean free path, which then results in a higher resolution of the X-ray lithography process, while exposure dose and photon absorption fluctuations under the given constraint of 0.1 μm maximum total error increase the probability of defect formation. The authors thank Yu.S. Kasyanov and V.I. Mishachev for assistance and discussions. Figures 3; references 10.

UDC 621.328

Electrical Conductivity of Silicate:P Glass Layers Produced at Low Temperatures

917K0064D Moscow MIKROELEKTRONIKA in Russian Vol 19 No 6, Nov-Dec 90 pp 604-607

[Article by I. I. Belousov, V. M. Yefimov, and T. G. Dukhanova, Institute of Semiconductor Physics, USSR Academy of Sciences]

[Abstract] An experimental study of silicate:P glass films used for interlayer insulation was made concerning their electrical conductivity. Such glass was produced by oxidizing a mixture of trimethyl phosphate and monosilane in a reactor under a low pressure of 50 Pa, with the P_2O_5 content varied over the 1.5-8.0 wt.percent range, and about 100 nm thick films of it were deposited on substrates of KEF-4.5 silicon at 420°C temperature. The actual P_2O_5 content was determined on the basis of the etching rate, whereupon the phosphorus concentration was additionally measured by Auger and infrared spectroscopy. Subsequent measurements were made with these films and with SiO_2 layers (produced at 300°C pure or with addition of ammonia) built into MOS-structures with aluminum contact leads. In expectation of a large ion current component in heavily doped dielectric films, (+) charge buildup was measured as a function of time over a period of about 300 s. The results indicate an electronic conductivity mechanism, however, with phosphorous atoms not directly participating in the charge transfer. The dependence of the current density on the electric field intensity was then determined on the basis of voltage-current measurements, the electric field intensity being varied from << 1 MV/cm to about 4 MV/cm and the current density correspondingly rising from nA/cm^2 to μA/cm^2 levels. Further measurements with both the temperature and the voltage varied were made for made for determining the temperature dependence of the electrical conductivity and the field dependence of the conductivity activation energy. The current density at each electric field intensity was found to increase exponentially with rising temperature. The conductivity activation energy was found to decrease linearly from 0.7 eV to 0.5 eV as the electric field intensity was raised from << 1 MV/cm to about 4 MV/cm. The results indicate the same mechanism of electrical conductivity operating at low temperatures in silicate:P glass films and in SiO_2 layers produced at a lower temperature. Quantitative differences are evidently due to structural changes resulting from implantation of phosphorus atoms. The authors thank L.L. Vasilyev for assisting in preparation of pure SiO_2 layers and for discussing the results. Figures 3; references 9.

UDC 621.382

Electrical Conductivity of Insulating and High-Resistivity Materials in Strong Electric Fields

917K0064E Moscow MIKROELEKTRONIKA in Russian Vol 19 No 6, Nov-Dec 90 pp 608-613

[Article by Ye. V. Grekov and O. G. Sukhorukov]

[Abstract] The mechanism of charge carrier injection into a dielectric or a high-resistivity semiconductor with a uniform concentration of monoenergetic traps is analyzed, those carriers being of one kind and being pulled into the conduction band as they are captured by traps during passage of a current. Injection of electrons and a

negative space charge are considered for specificity, assuming that the empty traps have a Coulomb attraction potential as do compensated donor traps. Current passage through such a material is described by a system of three equations, one of them being the equation of carrier capture and release kinetics including the Poole-Frenkel effect and accordingly the field-dependent probability of carrier release from a trap. This equation is supplemented with the Poisson equation and the continuity equation. The maximum steady-state current is calculated on the basis of these equations with all time derivatives set to zero. The current-voltage characteristic is then obtained from the universal relation between the magnitude of the space charge and its centroid (space coordinate of its center), first assuming that the carrier mobility does not depend on the field intensity and then considering that in strong fields it will decrease down to saturation level of the drift velocity. Calculations are made for the case of limited carrier injection and for a virtual cathode simulating injection through a pool contact. Figures 2; references 11.

Ionosphere and Long-Range Shortwave Propagation

917K0085A Moscow RADIO in Russian No 10, Oct 90 pp 10-13

[Article by G. Ivanov-Kholodnyy, Troitsk]

[Abstract] New scientific data on the planetary distribution pattern of the ionosphere obtained by the Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation at the USSR Academy of Sciences (IZMIRAN) are described. It is demonstrated that new data on the ionosphere's planetary distribution and computations of radio wave paths enable us to advance our understanding of the conditions and times of good radio wave propagation and the factors affecting these conditions. It is emphasized that despite the new observation facilities being employed by experts, the problem of long-range shortwave propagation is so complex that it calls for using help from ham radio operators. It is suggested that in future studies hams should provide data on UHF-VHF radio wave reflection by *aurora borealis* as well as electric conduction of the soil. A program of future studies encompassing long-term experiments to record signals from several standard transmitters located in the southern hemisphere and estimate the signal level is proposed. References 4; figures 4; tables 1.

Where Microwave and EHF Devices are at Work

917K0085B Moscow RADIO in Russian No 10, Oct 90 pp 14-16

[Article by Ya. Fedotov]

[Abstract] A continuation of an article in *Radio* No 8, 1990. Applications of microelectronic instruments and their likely advantages in both traditional and nontraditional fields of radio electronics are described, e.g., in the 20/40 GHz band for military communication satellites, in the 22-60 GHz band in weather satellite radiometers, etc. Special attention is focused on direct satellite TV reception units employing microwave (SVCh) devices operating in the 12 GHz band with a 500 MHz bandwidth. The effect of phased antenna arrays (FAR) on the development of microwave IC's is assessed. The transceiver of a FAR radar unit consisting of a low-noise input amplifier, a frequency converter/mixer, an oscillator, and an IF preamplifier on the receiving end and a power amplifier driven by a central reference phase generator on the transmitting end is described in detail. A number of devices used to control amplitude and phase in the unit, such and a digital-to-analog converter, phase shifters, optoelectronic converters, fiber optic lines, Y-junctions, and microstrip waveguide transmission lines are described and their characteristics are cited. Problems of designing and manufacturing monolithic microwave IC's are described. The conclusion is drawn that monolithic integrated circuits are the most promising in the development of microwave IC microelectronics. Figures 2.

Ham Radio 'Telephone'

Moscow RADIO in Russian No 10, Oct 90 pp 29-32

[Article by V. Besedin (UA9LAQ), Tyumen]

[Abstract] A new ham telephone operating in Tyumen since 1 December 1987, i.e., a network of simplex FM or PM VHF-UHF radio stations using a fixed frequency of 145.5 MHz, is described. A new equipment complex consisting of a transceiver, a power supply unit, an antenna, and a converter was developed for the network. The equipment was used to contact the astronauts on the Mir orbital station. The transmitter has a controllable power output of up to 5 W and is stable and protected from surges; it does not interfere with TV and radio broadcasts due to good screening; it uses phase modulation with a plus or minus 1.5 kHz frequency deviation; the receiver is a single conversion superheterodyne employing primarily FET's and IC's; it has a noise suppressor and an economizer. Given an SNR of 10 dB, the receiver has a sensitivity of 0.4 μV with the suppressor and 1μV when both the suppressor and economizer are used. Its adjacent channel selectivity is at least 60 dB given a 25 kHz spacing. Transceiver specifications and operating data are summarized in detail. Figures 8.

Multiple-Command Remote Control System

917K0085D Moscow RADIO in Russian No 10, Oct 90 pp 39-43

[Article by S. Biryukov, Moscow]

[Abstract] A coder and a decoder which make it possible to develop a remote control system with simultaneous transmission of up to seven discrete commands is

described. A pulse counting code is used to transmit commands; the seven commands alternately transmitted in each operating cycle correspond to bursts of one-to-seven pulses. Circuit diagrams of the coder and decoder and signal time charts at various characteristic points are presented. The coder consists of a square pulse generator, an encoder, and an output transistor switch. The operating principle of the system is described in detail. The control signal generation process is examined. It is shown that the coding and decoding principle considered in the article makes possible to obtain different combinations of the transmitted commands both simultaneously and alternately. References 1; figures 7.

Phase Alternation Line Signal Decoder on K174KhA28 Integrated Circuit

917K0085E Moscow RADIO in Russian No 10, Oct 90 pp 50-54

[Article by A. Mikhaylov, I. Novachenko, Moscow]

[Abstract] The K174KhA28 phase alternation line (PAL) signal decoder's integrated circuit which is a clone of the TDA3510 integrated circuit is described; it decodes PAL signals and produces negative polarity chroma on the output. The integrated circuit's diagram is presented and its operating principle is described in detail. The decoder connection diagram, its components, and its setup and tuning are described. When connected to a commercial color TV, the PAL signal decoder enables the user to view videotapes recorded in both the SECAM and PAL standards. References 7; figures 7.

School - Aerospace - Information

917K0074A Moscow RADIO in Russian No 9, Sep 90 pp 5-8

[Article by A. Grif]

[Abstract] A team at the Special Design Office at the Moscow Institute of Energetics has conceived and is developing a Unified State System of Information for Public Education (YuGSINO). The aim is to link all educational and professional institutions in the USSR to all available data banks and depositories of knowledge by a communication network which includes space satellites and to which schools can access either directly or through regional computer systems. Opponents of this project, essentially bureaucrats, have been won over following their conversion from "traditional" dampers of all progress to enthusiastic supporters. This is best expressed by V.Ye. Shukshunov, vice-chairman of the USSR State Education Commission, in his view on the role of computers and information technology in education, on the need for training computer specialists, and on the need for public learning of computer techniques. In an interview with a correspondent of RADIO, K. Pobedonostsev described the overall concepts of this YuGSINO system, while V. Moshkin and Ye. Shilnikov then described the specific technical details. Use of foreign-made computers is contemplated and contact has accordingly been established with foreign computer manufactures (IBM), also with UNESCO, to explore interest in collaboration on this project. Figures 1.

Packet Radio Communication Network

917K0074B Moscow RADIO No 9, Sep 90 pp 9-11

[Article by S. Bunin, UBSUN]

[Abstract] Soviet radio amateurs will since 1 March 1990 be able to use digital radio links to radio networks which operate in the packet switching mode including multiple access with carrier checkout, each transmitted packet containing a checksum for detection of errors due to interference, to possible overlap of packets, or other causes. Any computer such as Radio 86 RK, "Mikrosh", or other can be used as terminal network computer with a packet message monitor which will automatically process messages according to applicable protocols. Data are transmitted in the non-return to zero inverted (NRZI) code. A data transmission speed of 300 bauds has been selected for high-frequency channels, provided that the operating frequency is close to the maximum usable for ionospheric propagation, a lower transmission speed being required otherwise so as to avoid errors due to overlap of data packets. A transmission speed of 1200 bauds has been selected for UHF channels, 2400 and 4800 bauds being tried experimentally in several countries. Distortion of the signal spectrum in 400-3400 Hz channels is prevented by use of modems with single or double phase-shift keying. Nonautomatic continuous-wave single-sideband radio transmission is preferred for personal messages, the overall time of message processing print-in to print-out time being usually not too long even though the transmission speed alone is six time lower than by teletype. Preference is also given to UHF channels, transfer from one network to another such as from one operating in the HF range to one operating in the UHF range or from one UHF frequency to another being effected by means of GATES and NODES. Inasmuch as the number of nodes through which a logic connection can be established is infinite, unlike the number of gates, it is possible to set up a Bulletin Board System of "mail boxes" in arbitrarily many nodes. These "mail boxes" are computers with a large memory capacity often exchanging information in the automatic FORWARD mode so as to ensure that messages reach those for whom they are intended. The problem of designing the most suitable packet radio communication network in the USSR is analyzed, this problem being one of matching available means with the specific needs in this country.

Right to Use of Airwaves

917K0074C Moscow RADIO in Russian No 9, Sep 90 pp 11-12

[V. Shevchenko, chief, staff-operated radio station of Boarding School for Blind Children imeni V. G. Korolenko, Donetsk - Kharkov]

[Abstract] The first conference of the Ukrainian Society of the Blind held in Donetsk dealt with legal and practical aspects of the right which blind persons have to the use of airwaves for recreation, particularly as both radio and sports amateurs. The availability of radio apparatus for the blind and their ability to operate it was demonstrated by an exhibit of components designed for handling by ear rather than by eyesight. The ability to effectively operate radio apparatus was demonstrated by young "hams" from the Boarding School for Blind Children imeni V.G. Korolenko in Kharkov, a model for other such schools. Figures 1.

House Alarm Device

917K0074D Moscow RADIO in Russian No 9, Sep 90 pp 32-33

[Article by I. Aleksandrov, Kursk]

[Abstract] An device for protection of an entire building or individual rooms against intruders is described which either generates a a sound or visual alarm signal, or transmits an electric signal to an attended main desk. The device contains digital microcircuits with a CMOS structure, namely two logic elements forming an RS-trigger, two logic elements acting as voltage comparators, and four inverters. Other components include four resistors, two capacitors, one diode, and one optron with a light-emitting diode, a varactor diode, and a photoresistor. The alarm is set by an outside switch. An inside switch has contactor pairs mechanically connected to a door or window. The optron can be replaced with a switching transistor and a relay in its collector circuit. The device is energized by a built-in 9 V size GB1 battery, use of CMOS components reducing the current drawn from it to several microamperes only. The external servomechanism is designed to suit specific requirements. A similar alarm device can be designed for automobiles and, accordingly, connection to an external 12 V battery. Figures 1; references 1.

UDC 621.375.029.45

Analog Electronic Control of Signal Level

917K0063A Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 90, pp 22-30

[Article by E. P. Tarasov, S. V. Sidorov, and O. V. Plyushcheva, Central Design Office of Cinematography, Scientific-Industrial Association "Ekran" (Screen)

[Abstract] Analog regulation of signal level by the effective method of conversion to logarithm and antilogarithm is considered, a signal level regulator being treated as an amplifier with voltage control. Electronic integrated-circuit level regulator modules for the mixer, for compression of the dynamic range, and for sound recording are described, all three suitable for small studios. The logarithm channel of the level regulator for a UMU 3 mixer consists of a common-base transistor pair with negative feedback and an operational amplifier, while its antilogarithm channel consists of a common-base transistor pair and an operational amplifier with an additional transistor pair for level setting. The level regulator for the similarly constructed 60U623 compressor is connected to the latter through a switch and consists of three operational amplifiers: one acting as frequency corrector, one attached to a full-wave rectifier, and a d.c. amplifier behind an automatically switchable R-C charge-discharge network. Signal compression is achieved owing to the nonlinear emitter junction of the "antilogarithm" transistors in the mixer regulator module, high accuracy and stability which includes insensitivity to temperature changes being achieved as a result. The compression ratio is set by a switch, usually set to 1.6 or two but also arbitrarily to any value such as 20 for limiting, with visual indication by a light-activated diode in the 60U623 compressor module. The level regulator for magnetic sound recording is essentially an amplifier consisting of two complementary logarithm-antilogarithm transistor pairs with an operational amplifier and a resistor each, in a symmetric configuration so as to minimize even harmonics. The proposed schemes are tentative, subject to modification as new design concepts are developed and performance characteristics need to be improved. Figures 7; references 8.

UDC 621.397.446:621.397.132

Design of Fifth-Generation Television Receiver

917K0063B Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 90 pp 42-45

[Article by V. A. Kupriyanenko and V. V. Movchan, Scientific Research Institute of Television Engineering "Elektron" (Electron)

[Abstract] A new color television receiver TTsI-ATs has been developed ready for commercial production in 1991. It has been designed for SECAM, PAL, NTSC standards D,K,B,G,M,L and for TELETEXT information display, also for playback of bilingual as well as monaural and stereophonic sound tracks. Its operation is based on analog processing of video and audio signals with digital control. Its functional components include a kinescope with a deflection system, an intermediate-frequency channel, two low-frequency amplifiers, a sound channel, a built-in sound system, a teletext decoder, a color data decoder, a sync-signal processor and vertical-sweep monitor module, a horizontal-sweep module, two modules for central control and remote control of the color image generator respectively, and a channel selector, a power supply, and an external commutator switch. It includes provisions for direct selection and taping of programs broadcast over UHF and VHF channels, for station search and precise tuning, for storage of dial settings and program numbers in a memory, for hookup by peripheral SCART plug to external sound systems, headphones, audio tape

recorder, video tape recorder, or personal computer, and for switching to standby mode in the absence of an input signal. Central control is effected by means of an IC "Bzaimodeystviye-2" (Interaction) micromonitor on a single chip carrying an 8 kbyte read-only memory, a 128 byte random-access memory, two independent counter-timer units, three 8-digit input/output ports, a sequential interface, a digital detector with signaling to remote control, and an interrupter. The central control module contains also an IC "Elevant" (?) pulse code preamplifier and a IC "Relef-2" (Contour) electrically reprogrammable read-only memory. The color data decoder MTs-51 module for decoding and also amplifying SECAM, PAL, NTSC-3.58/4.43 chrominance signals consists of an IC "Satis" multisystem chrominance processor, a chrominance-signal wavefront corrector, a luminance-signal delay line with gyrators and delay regulation, a video signal processor with built-in IC "Sterzya-3" (?) dark-current stabilizer, and a an IC "Farukh" (?) 12S busbar interfacing it with the central control module. Figures 1.

UDC 621.397.743.003.1

Cable Television in Evolution of Market Relations

917K0063C Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 90 pp 46-56

[Article by A. Barsukov]

[Abstract] Introduction of cable television is examined from the standpoint of evolving market relations, a key element being the contract and its implications inevitably influenced by market value indicators. Four types of contract are considered: formal, real, consensual, and literal. Contract negotiation and settlement techniques are analyzed, following definition and explanation of such basic concepts as objective, trust, worth, conditions, mutual responsibilities, arbitration, and judicial enforcement. This contract aspect of cable television market economics is subsequently discussed as it relates to creation of a future national USSR network, of great interest being experience and practices in operation and management of cable television networks in the United States and in the European Economic Community. Recent changes in Eastern Europe as well as competition from Western European and American broadcasters have resulted in curtailment of the market for Soviet television programs. Another example of a factor which influences the television outlet market is organization of the satellite communication system.

UDC 006:778.534.455

Standardization of Magnetic Film Phonograms on 16 mm Punched Tape in Television Production of Magnetic Film Phonograms

917K0063D Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 9, Sep 90 pp 56-58

[Article by L. S. Leytes and A. S. Krupkin, Television Engineering Center imeni October Semicentennial]

[Abstract] A new OST Gosteleradio USSR (All-Union State Radio and Television Standard) complying with ISO 4242-80 definitions and terminology is proposed, to replace the obsolescing OST 58.3-83 and to include new specifications for SEPMAG magnetic film phonograms on 16 mm on punched tape. It sets +0/-0.1 mm tolerances on width variation of the three tracks, widens the outer track and narrows the center track so that they become identical, but does not change the control track. It also revises the track assignment: single-track information to be recorded on the center track, identical information for international exchange to be simultaneously recorded on both center and outer tracks so as to ensure interchangeability, stereophonic programs to be recorded in the left-hand channel of the center track, bilingual programs to be recorded in the original language on the center track and in the other language on the outer track. Other information such address or time is to be recorded on the control track in either analog or digital form. The advantages of this new All-Union Standard will be: 1) availability of two identical tracks; 2) elimination of the need to produce an extra film phonogram modification and particularly a special one for international exchange; 3) universality of magnetic heads with respect to reproduction of old and foreign films in terms of click noise, as demonstrated by the dependence of its relative level on the track width. A drawback of the new All-Union Standard is a 1 mm narrower center track, 4 mm instead of 5 mm, but a corresponding 1 dB increment of the noise level will be hardly perceptible. Figures 3; references 6.

UDC 621.397.132.129

High-Definition Television and TV Theaters

917K0053A Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, Aug 90 pp 14-26

[Article by P. N. Gisich, D. D. Sudravskiy, and A. I. Shabunin, Moscow Scientific Research Institute of Television

[Abstract] Use of high-definition television (HDTV) systems in TV theaters is considered, such theaters being for this purpose classified into five categories: home theaters (up to 10 viewers), small public ones (up to 50 viewers), medium public ones (up to 500 viewers), large public ones (up to 10,000 viewers), and open-air including mobile theaters (up to 50,000 viewers). Six modes of image projection are compared from the design and application engineering standpoint: 1) by reflection, 2) by transmission, 3) with superposition of images on one screen, 4) with splicing of images on one screen, 5) with collation of images from several projectors on same screen, 6) projection onto polyhedral (cube) screens. Projectors using a kinescope and projectors using an optoelectronic light modulator-valve are compared in terms of design and performance characteristics, of particular concern being both optical and vertical resolutions attainable with the latter kind of projector. The

latter include Talaria (General Electric), Eidophor (Gretag, Switzerland), BTsTE (USSR) projectors, also some with liquid-crystal light modulators (Victor, Seiko, Sanno Electric). Several kinds of reflecting screen (Kodak, Hitachi, Panasonic) and several kinds of transmitting screen (Hitachi, Panasonic) are also compared in terms of design and performance characteristics. Noteworthy is the feasibility of setting up HDTV networks as wideband fiber-optic image communication lines become available. Figures 7; tables 8.

UDC 621.395.81

Measuring Wind Susceptibility of Microphones

917K0053B Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, Aug 90 pp 30-32

[Article by V. S. Bulatov and Ye. S. Estrin, Central Design Office of Cinematography, Scientific-Industrial Association "Ekran" (Screen)

[Abstract] A device for measuring the wind sensitivity of microphones has been designed and built, an improvement over the Bruel device. The microphone is mounted at the free end of a cantilever beam which oscillates about a horizontal shaft driven by an electric motor and thus produces an air stream which simulates wind blowing at a harmonically varying velocity. On the beam, behind the microphone and facing it, is also mounted a calibrating loudspeaker. An electric signal is applied to the latter so that the amplitude and the frequency of the microphone output voltage will correspond to the microphone sensitivity. A weight mounted on the beam behind the loudspeaker stabilizes the oscillation amplitude. Unlike the Bruel device, which is rated for the 2.8-11 m/s range of wind velocities, this one has a high immunity to acoustic and vibration noise so that it covers a much wider range of wind velocities on both low and high side. It is also more efficient, inasmuch as it does not require switching for a change of wind velocity or wind direction. Its reliability can be improved by recording the microphone output signal over several oscillation cycles. Better wind screens for microphones can, therefore, be designed on the basis of these measurements. Figures 4; tables 1; references 4.

UDC 654.197.313

Alternatives for New Television Broadcasting Systems

917K0053C Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, Aug 90 pp 39-41

[Article by S. V. Novakovskiy, A. I. Shvidun, and J. Vael, Moscow Institute of Communications]

[Abstract] The various available high-definition television systems are compared for use in future color television broadcasting, the principal among them being NDTV not compatible with NTSC and ACT (Advanced Color Television compatible with NTSC. As standard systems besides NTSC are also to be considered PAL and SECAM systems as well as the SWPS (Single World Production Standard). Not only technical but also socio-economic factors need to be considered in developing a strategy for development of a HDTV system in the USSR, after questions of purpose and validity have been answered. References 6.

UDC 621.397.444+621.397.743

Cable Television and Stardom

917K0053D Moscow TEKHNIKA KINO I TELEVIDENIYA in Russian No 8, Aug 90 pp 42-50

Article by A Barsukov]

[Abstract] Future management of USSR cable television is examined by comparing present methods here and abroad, especially in the United States, where stars are the key to successful operation. Principles of management and financing are analyzed from the standpoint of creativity rather than routine production techniques. Considering that every USSR citizen has been legally granted the exclusive right to control his or her talents, there arises the problem of reward. Whether lump sum or royalty payments are made to a star, there is seen a need for floors and ceilings so that inadequate as well as excessive remuneration can be avoided. Various practices such contract agreements, review, and regulation are exanined, also the role of communicators who provide the link between program creator and viewer. One important consideration is the authors' right to freely choose a way to protect their interests, whether individually and often by engaging an agent or collectively by forming an association. Another important consideration are the viewers' rights, access to reliable information and to good taste in entertainment. Many of these concepts are not relevant in present USSR television, where monopoly in the field of mass communication needs to be confronted by free competition so as to avoid entrenchment and to stimulate improvement. How this will work in future USSR television is to a large measure unknown. As far as stardom is concerned, the American experience suggests that a television celebrity must have talent, be prominent, look like heroes of the time, conform to fashions of the time, project sagacity preferably backed by a degree from a prestigious university, have a penchant for far-off causes, and avoid oblivion. Tables 3; references 5.

Television Receivers 4USTsTt: Power Supply and Network Filter Board

917K0059A Moscow RADIO in Russian No 8, Aug 90 pp 46-49

[Article by V. Konashev, Moscow]

[Abstract] The power supply module MP-4-5 for "Rubin 51TTs405D and 61TTs405D" color television receivers

consists of a pulse transformer with group stabilization of secondary voltage and a transistor switch, energy being stored in the transformer when the switch is open and being transferred to the load upon closing of the switch. The transformer primary is connected to the 220 V a.c. network through a line filter. The power supply has +12 V d.c., -15 V. d.c., +15 V d.c., +125 V d.c., +24 d.c. output and two frame-grounding terminals. Its operating range is 170-250 V a.c. on the input side. Its voltage regulation at the +125 V d.c. output is 1 percent over the 0.25-0.4 A range of load current, with a ripple voltage not exceeding 0.5 V under a 0.4 A load. The ripple voltage at its +24 V d.c., +12 V d.c., and +/-15 V d.c. outputs does not exceed 0.2 V under a 0.4 A load, 0.02 V under a 0.5 A load, and 0.2 V under a 0.5 A load respectively. The power supply has built-in control with time delays appropriate for start, voltage regulation, and protection against overload up to short-circuit level. Its efficiency is at least 80 percent and it weighs 1 kg. The line filter suppresses high-frequency interference from the power supply, produces as voltage for the kinescope demagnetizer, of the kinescope, and automatically turns the receiver off when there is no input signal (broadcast sign-off) or there is a fault in the horizontal sweep circuit. Figures 3.

Outdoor UHF Receiver Antenna

917K0059B Moscow RADIO in Russian No 8, Aug 90 pp 50-52

[Article by G. Nunuparov, Lyubertsy (Moscow Oblast)]

[Abstract] A simple semigraphical method of designing log-periodic antennas for reception of UHF television broadcasts is shown, directive gain and frequency band being the only two design criteria to be satisfied. The optimum lengths of dipoles and distances between them are determined from σ-τ graphs (τ- common ratio of geometric progression, σ- distance in wavelengths from the half-wave and thus longest dipole to its shorter neighbor), the optimum σ corresponding to minimum τ for a given directive gain and also to minimum voltage standing-wave ratio. Inasmuch as $\sigma = 0.25(1- \tau)\cot\alpha$ (α- angle between antenna axis and line passing through the tips of all dipoles), α is then readily found from this relation with both σ and τ having been fixed by tradeoff. An antenna with a very large σ will have a radiation pattern with many lobes. The number of dipoles N and the length of the antenna L (distance from longest dipole to shortest) are determined from B-α graphs ($B_A = B_S/(f_{max}/f_{min})$, B_S- width of "active" zone of the resonant dipole and its two neighbors). An antenna with a directive gain of 8.5 has been designed according to this procedure for channels 21-60 covering the 470-790 MHz frequency range (max/min= 1.68). Its parameters are $\tau = 0.82$, $\sigma = 0.15$, $\alpha \simeq 17°$, $B_S = 3.53$, L = 375 mm, N = 7. Figures 4; references 4.

Outlook for Development of Tuners in USSR

917K0059C Moscow RADIO in Russian No 8, Aug 90 pp 53-54

[Article by V. Konovalov, Leningrad]

[Abstract] The domestic demand for tuners has decreased since their first appearance on the market in 1974-75, this being attributable to several causes. The interest in radio listening has decreased on account of inadequate programming and availability of alternatives such as tape recorders. The interest in purchasing new radio equipment components has correspondingly decreased and not least because of the cost factor, a tuner adding 15 percent to the cost of a radio receiver set, also because of poor advertising. Another factor is limited access to outdoor UHF antennas, residential houses lacking them altogether. Production of tuners at three plants (imeni V.D. Kalmykov in Sevastopol, "Priboy" in Taganrog, "Punane RET" in Tallinn) has been altogether discontinued. Few tuners are still produced in 1989 and only for large stereophonic systems such as "Romantika T-120-stereo" assembled at the Kharkov plant and "Oda T-102-stereo" assembled at the Murom plant. A new tuner "Radiotekhnika T-7111-stereo" has meanwhile been developed by the Industrial Association "Radiotekhnika" (Radio Engineering) in Riga for the K-111 built-in stereo set. It is designed for reception of monophonic radio programs on long-wave to short-wave channels as well as monophonic and stereophonic radio programs on UHF channels. It has three audio outputs for hookup to a stereotelephone, with smooth volume control, as well as to an audio-frequency amplifier and to a tape recorder. The tuner is built with old integrated-circuit chips so that its electrical performance characteristics are not better than those of the tuner in the "Radiotekhnika T-101-stereo" system. The module weighs 5 kg. Pilot production has been scheduled for 1990 and commercial production should follow. Figures 1; tables 1; references 3.

Applications for Series K555 Microcircuits

917K0059D Moscow RADIO in Russian No 8, Aug 90 pp 59-63

[Article by S. Alekseyev, Moscow]

[Abstract] Thirteen series K555 microcircuits are described, each encapsulated in a 7.5 mm wide plastic case with two rows of pin terminals 2.5 mm apart: one row on each side. The K555IYe19 (14 pins) consists of two four-digit binary counters. The K555IYe20 with 16 pins consists of two four-digit binary-decimal counters. The K555IR35 with 20 pins is an eight-digit storage register. The K555ID18 with 16 pins converts binary-decimal 1-2-4-8 code signals into control voltages for a seven-segment indicator. The K555LA11 (14 pins) consists of four NAND gates with open collector. The K555AP3 (20 pins) consists of eight inverting buffers with a high load capacity, up to 24 mA with 0.5 V at "0" level and up to 15 mA with 2 V at "1" level with

possibility of transition into Z-state. The K555AP4 (20 pins) consists of eight noninverting buffers with invertible control and Z-transition inputs, being otherwise similar to the K555AP3 in terms of load capacity and time delays. The K555AP5 (20 pins) consists of eight noninverting buffers in two groups of four, each having invertible control inputs, and is otherwise similar to the K555AP3 in terms of load capacity and time delays. The K555AP6 (20 pins) consists of eight bidirectional noninverting buffers with two groups of eight input/output ports and two control inputs. The K555IP6 (14 pins) consists of four bidirectional inverting buffers with two groups of four information input/output ports and two control inputs, "0" not allowed to not appear at both inputs simultaneously but "0" at one and "1" at the other pulling all information input/output ports into the Z-state. The K555IP7 (14 pins) consists of four bidirectional noninverting buffers and is otherwise similar to the K555AP6. Typical applications for these microcircuits are signal switching in microprocessor and hookup of peripherals to a "Radio-86RK" computer. Figures 6. references 6.

Digital Noise Generators

917K0059E Moscow RADIO in Russian No 8, Aug 90 pp 69-71

[Article by M. Marder and V. Fedosov, Taganrog]

[Abstract] The design of digital devices generating "digital" noise in the form of a pseudorandom process very similar to physical noise is analyzed, these devices being used in preference to "noisy" circuit elements for measurements and tests not only because of their higher noise power but also because of the higher time and temperature stability as well as more uniform frequency characteristics of their parameters. Inasmuch as a pseudorandom M-sequence of binary symbols (rectangular pulses of random duration separated by intervals of random duration) is the one having the longest period with a given number of symbols, it is usually chosen for simulation of noise. The authors have on this basis built and tested a digital generator of "white" and "pink" noise for a panoramic spectrum analyzer with an equalizer, this instrument to be used as real-time monitor of sound channels such as a sound track on stereophonograms. Its M-sequence formed by an N-digit shift register with a modulo-2 adder is periodic and contains all 2^N- 1 binary combinations of register states, except the zero combination, within one period $T_N = (2^N)/f_T$ (f_T- clock frequency). This noise generator has been designed for N = 23 and f_T = 150 kHz so that T_N = 56 s. Its frequency band is 20 kHz wide with a spectrum nonuniformity not exceeding 0.5 dB and the maximum frequency separation between spectrum components is 0.018 Hz. The register is built with CMOS elements, series 176IR10 chips being most suitable, and has only one feedback loop for maximum simplicity and minimum cost. The noise generator includes a trigger circuit, which prevents the zero combination of symbols to appear simultaneously in all register cells when the power supply is turned on. In addition to the clock-frequency oscillator, this noise generator includes also a conventional low-pass filter with two RC sections for extraction of white noise and a special low-pass filter with four RC sections piecewise-linearly approximating a logarithmic amplitude-frequency characteristic for extraction of pink noise. Figures 3; references 3.

UDC 538.566

On Electromagnetic Resonances in the Earth-Ionosphere Cavity

917K0087A Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 33 No 7, Jul 90 pp 771-775

[Article by E. M. Gyunninen, G. I. Makarov, Leningrad State University]

[Abstract] It is shown that Schumann's resonance and the subsequently discovered "transverse" high-frequency resonance are inseparable, i.e., are two sides of the same physical process. This conclusion makes it possible to develop the concept of helical waves for the zonal harmonics which represent the electromagnetic field in the Earth-ionosphere plane. For simplicity and without any loss of generality, a very simple cavity model is considered: the earth's surface and the cavity's ionospheric wall are perfect conductors while a TM-field is excited by Hertz's electrical vector. It is demonstrated that the transverse and longitudinal resonance are two cases of the same helical wave. References 4: 3 Russian, 1 Western; figures 3.

UDC 550.328.2

Experimental Results of Studies of Artificial Ionospheric Turbulence

917K0087B Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 33 No 7, Jul 90 pp 776-781

[Article by V. A. Gudin, V. N. Deyneko, V. I. Ivanov, Yu. A. Ignatyev, P. B. Shavin, Scientific Research Institute of Radio Physics]

[Abstract] The results of an experimental examination of the formation conditions and backscattering signal characteristics of an artificial area of perturbation and certain parameters of artificial ionospheric turbulence on various scales are cited. The study of backscattering signals from artificial electronic concentration irregularity areas was carried out in February and December 1987 between 1000 and 1700 hours using the Sura device. Geographic conditions of the experiment were monitored by an automatic ionospheric probe. More that 200 ionosphere heating sessions were conducted during the period of observations. An analysis of experimental results shows that the method of radio wave backscattering over two paths simultaneously is promising for diagnosing the artificial disturbance area formed during the interaction of strong radiation with ionospheric plasma. Yet, additional experiments are needed to refine the issues of generating artificial disturbances with various scales of dimensions, especially to clarify the complex behavior of the backscattering signal intensity during the operation of the heat transmitter and the issues of backscattering signal formation at various frequencies at altitudes 60-70 km below the powerful wave reflection height. References 12: 10 Russian, 2 Western; figures 4; tables 1.

UDC 621.396.62:523.164

Dicke Radiometer Calibration

917K0087C Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 33 No 7, Jul 90 pp 782-787

[Article by A. M. Aslanyan, A. G. Gulyan, V. R. Karapetyan, R. M. Martirosyan, E. A. Nagdalyan, Radio Physics and Electronics Institute at the Armenian Academy of Sciences]

[Abstract] A method of calibrating Dicke's switched radiometer for measuring both absolute and relative signal levels by using the instrument's own calibrated intrinsic noise is described. Error sources are analyzed. The proposed method is characterized in that the input calibration device with a switch is eliminated, so the radiometer input conditions are not upset; the calibration system does not call for using special passive or active noise generators; the number of absolute levels and their magnitudes are virtually unlimited; the calibration scale can be adapted to the signal's dynamic range; and the absolute calibration operation is performed in the low-frequency circuit using low-frequency resources making it possible easily to automate the process and attain the continuous calibration condition while directly producing the measurement results in a digital or analog form. The method was experimentally tested by the authors in radiometers intended for measuring the parameters of long-range satellite communication antennas. References 5; figures 2.

UDC 535.42

Equations for Electromagnetic Field Phase Restoration

917K0087D Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 33 No 7, Jul 90 pp 813-817

[Article by V. V. Kotlyar, V. A. Soyfer, the Samara [formerly Kuybyshev] Aviation Institute]

[Abstract] New results of an examination of the possibility of using basic equations of the scalar theory of diffraction to restore the phase of coherent electromagnetic pulse fields (EMP) based on intensity measurements on two or more proximate planes are cited. It is shown that if the EMP satisfies Helmoltz's unidimensional equation, one can derive a nonlinear approximate second-order ordinary differential equation for the unknown field phase on a given plane perpendicular to the field propagation direction which includes the measured intensity distributions on two proximate planes; if

the scalar monochromatic EMP satisfies a unidimensional parabolic propagation equation, one can derive approximate second-order linear ordinary differential equations for the unknown phase which contain the measured intensity distributions on several proximate planes; and if the EMP satisfies a two-dimensional parabolic propagation equation and the field amplitude on a certain plane perpendicular to the propagation direction is approximated by a harmonic function, this field's phase is uniquely expressed by the measured intensities on two proximate planes. References 6.

UDC 621.372.826

On the Maximum Energy Which May be Extracted From an Electromagnetic Field

917K0087E Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 33 No 7, Jul 90 pp 818-825

[Article by V. G. Polevoy, Radio Engineering Institute at the USSR Academy of Sciences]

[Abstract] The issue of the maximum energy U_{max} which an electromagnetic field may transfer to extraneous charges in absorbing dissipating media is addressed. In particular, it is shown that for fields which change harmonically in time at a frequency of ω in the absence of absorption on this frequency, the expression for U_{max} coincides with a known expression for the total electromagnetic field energy in dissipating media. General results are illustrated by several specific media models. It is demonstrated that the energy in question depends on the field disengagement law; it is also shown that in order to find the maximum energy, it is sufficient to know the medium's dielectric constant without any constraints on the dissipation law and absorption magnitude. The author is grateful to S. M. Rytov and the participants in his Moscow seminar on radio physics for discussing the experiments and making suggestions. References 7.

UDC 538.56

Examination of the Atmospheric Radiance Characteristics Over the Sea Surface

917K0087F Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 33 No 7, Jul 90 pp 880-882

[Article by A. V. Volkov, A. R. Gliner, K. G. Kobyakov, K. V. Koshel, S. N. Krivonozhkin, O. B. Utrobin, D. V. Shannikov, B. M. Shevtsov, Pacific Oceanology Institute at the Far Eastern Branch of the USSR Academy of Sciences]

[Abstract] Vertical and horizontal polarization radiance temperature of the atmosphere was measured. The experimental unit consisted of a radiometer (receiver) with an antenna, a gyroscopic pickup, and a computer system. The antenna was freely suspended from the ship while the observation angle changed freely either as a result of pitching and rolling or manually and was measured directly with the help of the gyroscopic pickup. A 2.1 cm band radiometer was used as the receiver. Measurements were taken at the vertical and horizontal detection polarization. A parabolic reflector with a scalar horn was used as the feed. The data processing system consisted of a DVK-3 computer and three analog-to-digital converters. The results of thirty radiance temperature peak amplitude measurements were compared to the waveguide heights obtained by standard meteorological measurements. It is shown that vertical polarization measurements are the most suitable for detecting and identifying waveguide structures in the atmosphere. The authors are grateful to the staff of the Leningrad Hydrometeorological Institute for their data. References 4: 3 Russian, 1 Western; figures 3.

UDC 520.27

Balanced Radiometer

917K0087G Gorkiy IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 33 No 7, Jul 90 pp 887-888

[Article by V. G. Panadzhyan, Byurakan Astrophysical Observatory at the Armenian Academy of Sciences]

[Abstract] The design of a balanced radiometer is proposed; it differs favorably from that of a switched radiometer in that it eliminates modulation and demodulation of the noise signal being measured thus eliminating the weak input signal power loss sources. The block diagram of the proposed radiometer is discussed; it differs from known balanced radiometer designs in that there is no dummy antenna in the radiometer's input circuit; an intermediate frequency (IF) amplifier is added to the compensating signal circuit whose gain is selected as a function of the antenna temperature; and a low-pass filer with a narrower transmission band is used in the compensating signal circuit. The receiver noise is used to equalize the radiometer's spurious signal. The procedure for calculating the radiometer's fluctuation sensitivity is described for various low-pass filter transmission bands. References 2; figures 1.

UDC 621.391.1

Nonlinear Filtration of Trajectory Data

917K0073A Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 3-7

[Article by A. I. Velichkin and A. N. Detkov]

[Abstract] A set of algorithms is constructed, in accordance with Markov's theory of nonlinear signal filtration, for extraction of data on the trajectory of an aircraft in a turbulent atmosphere. Radar measures spherical coordinates, but its readings are filtered after they had been transformed into rectangular coordinates and then taking into account the strong probabilistic relation between changes of two coordinates (a high velocity along one coordinate most likely being accompanied by a low velocity along another). Radar readings are assumed to include white noise which, after statistical processing, becomes colored by time correlation. Optimum filtration requires an adequate mathematical model of flight trajectory, a system of three differential equations based on geometrical relations in the navigational velocity "triangle" with small yaw angles being an adequate one for describing horizontal flight at given track angle and altitude. Figures 4; references 11.

UDC 621.391.833

Algorithm for Estimating Spatial Distribution of Velocities in Radar Watch Systems

917K0073B Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 7-9

[Article by A. A. Lavrov]

[Abstract] An algorithm is proposed for estimating the spatial distribution of velocities when the target consists of many reflectors and the differences between their Doppler frequencies are narrower than the passband of radar Doppler filters. All the N reflectors are assumed to be equidistant from the linear radar antenna and their location is defined in terms of column vector θ (θ_i- angle between normal to the antenna aperture and direction to the i-th reflector), only the radial component of the reflector velocity relative to the radar antenna being responsible for the Doppler frequency shift [q=] 2kV (k- wave number, V- velocity of reflector relative to radar antenna) of received signals. Radar readings are formed from the envelope of echo signals and the diagonal NxN matrix of their complex amplitudes, assuming that their complex amplitudes as well as both velocity V and orientation angle θ of each reflector remain constant within given time period T and spatial range X in the presence of additive white background noise n(x,t). These readings carry information about the waveform of the transmitted pulse and are influenced by the energy characteristics of the radar set. The state of the target characterized by the spatial distribution of the velocities of its reflecting elements is determined from simultaneous estimates of their orientation angles θ and the Doppler frequency shifts ω, the estimation algorithm being optimal with respect to the maximum a'posteriori probability density criterion. Figures 1; references 4.

UDC 621.396.24

Reflection of Long-Delayed Echo Signals by Ionosphere

917K0073C Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 10-13

[Article by A. G. Shlionskiy and O. I. Yarko]

[Abstract] Data on solar and magnetic activities gathered during the nineteen twenties in Oslo, Eindhoven, London, and Pulau Kondor (Southern Indochina) are compared with later data on critical and maximum usable frequencies of the F-layer, measurements of the ionosphere having been made more recently with a worldwide network of ionosondes. Analysis of all these data indicates a possibility of the ionosphere reflecting short-wave echo signals, when their frequencies are lower than maximum usable ones, without much attenuation and dispersion and with small Doppler frequency shifts but with long time delays ranging up to 60 s. Earlier, a time delay of 2.5 s was interpreted as corresponding to reflection by the moon. The new evidence should be useful in determining the conditions for stable propagation of radio signals. Figures 3; references 14.

Measurement of Sea Ripple Characteristics With Amplitude Limitation in Radar Channel

917K0073D Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 21-23

[Article by I. Ye. Ushakov]

[Abstract] Measurement of the average frequency of echo signal envelope fluctuations with a navigation radar on shipboard for the purpose of determining the characteristics of surface waves on the Pacific Ocean is analyzed, considering that the echo signal is a sequence of video pulses reflected by a segment of the water surface and that some amplitude limiting in the radar channel is inevitable. Measuring the average envelope fluctuation frequency on the basis of the most likely fluctuation period is shown the be free of the systematic error of its conventional measurement as half the number of average-level crossovers by the envelope within one sampling period. This is confirmed by the results of an experiment using a "Mius" navigation radar on a ship at speeds from 0 to 12 knots on water with waves of point 1-4 on the roughness scale. Measurements were made with pulses of 0.3 μs duration transmitted laterally, at 90° to the ship's course, and picked up after reflection by water surface segments 300 m behind the ship at correspondingly a 3° glancing angle. The average fluctuation frequency based

on the number of average-level crossovers by the envelope was always lower than that based on the most likely fluctuation period, the difference between them becoming larger as the sea became rougher and when the wind direction coincided with the direction of the radar beam. Figures 2; references 2.

UDC 621.3.019.3

Minimax Quantization in Digital Receivers of Pseudonoise Signals

917K0073E Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 50-53

[Article by D. G. Kozlov and S. V. Lyusin]

[Abstract] Minimax algorithms is constructed for quantization of pseudonoise signals in digital receivers in the presence of an arbitrary interference with limited peak power and unknown probability distribution function, randomization of the quantization thresholds being a useful technique of avoiding signal suppression in the presence of a strong interference at the input to the analog-to-digital converter. A receiver of binary signals is considered, its task being to distinguish between two equiprobable opposing pseudonoise signals produced by $+/-\pi/2$ phase keying of the carrier by a pseudorandom sequence at some clock frequency. The algorithms are applied to a specific case of an ideally noiseless receiver with analog demodulation of the carrier and digital demodulation of the pseudorandom sequence, such a receiver being synthesized with an analog-to-digital converter with q_n quantization thresholds and w_n quantization weights where n = 2,4,...,N or n = 1,3,...,N. The quantization thresholds are assumed to be random quantities independent of the readings within some probability density distribution. When that distribution is exponential, then the simplest analog-to-digital converter will be a deterministic functional one with a constant difference between successive interference readings $\Delta = c_n - c$ ($c_{n-1} \leq c_n$, $c_1 = \Delta/2$, $c_0 = -gD/2$). Figures 1; tables 1; references 6.

UDC 778.38:621.396

Reconstruction of Radioholograms Synthesized by Orthogonal Linear Antenna Arrays

917K0073F Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 60-62

[Article by P. D. Kukharchik, N. I. Kurilo, I. A. Titovitskiy, Ye. V. Bychinov, and V. V. Rubanik]

[Abstract] An algorithm is proposed for digital reconstruction of radio images synthesized on a hologram by two orthogonal linear antenna arrays. The gist of this algorithm is artificial formation of quasi-matched cylindrical reconstructing wavefronts with generatrices parallel to the antenna arrays for synthesis of an intermediate Fourier hologram. The image can then be reconstructed in real time by the method of fast Fourier transformations, first by rows and then by columns of the two-dimensional matrix which represents the complex values of that hologram. The algorithm eliminates spherical aberration and significantly reduces other aberrations, especially astigmatism. It was tested on two orthogonal linear antenna arrays of 128 elements each, one transmitting and one receiving, with the image of a metal ring as test object. The fast Fourier transformations were performed with the aid of an Elektronika 100-25 minicomputer, the total machine time not being longer than for the Fresnel reconstruction algorithm. Figures 1; references 4.

UDC 681.7.068:621.396.677.49

Hybrid Fiber-Optic Microwave Signal Distribution System in Active Phased Antenna Array

917K0073G Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 62-65

[Article by L. D. Bakhrakh and A. A. Bliskavitskiy]

[Abstract] The feasibility of a fiber-optic system for distribution of microwave reference signals on an optical carrier in an active phase antenna array is examined, taking into account the need for additional microwave amplifiers to compensate for loss of power during electronic-to- optical signal conversion in the transmitter and optical-to-electronic signal conversion in the receiver. Successive bifurcation of channels from 1 into N_1 in $N_k = \log_2 N_1$ stages is considered for distribution of the microwave signal from a very stable master oscillator, with a low-noise microwave amplifier in each channel of one of the tiers and a discrete 22.5° microwave phase shifter in each channel of the last tier. Each of the N_1 channels in the last tier sends a modulating signal to a single laser diode or an array of N_2 of them. Light emitted by each diode or array of diodes passes through an optical isolator and then enters a single-mode optical fiber, each fiber being split into N_3 channels by successive M-ary branching in $N_0 = [\log_M] + 1$ stages. Each channel of the last tier sends an optical signal through an optical phase shifter to a wideband photodetector, these phase shifters shifting the phase of the microwave envelope of the optical carrier maximally by 22.5°. A performance analysis of such a fiber-optic signal distribution system in terms of its power transmission and noise characteristics indicates how to optimize its design. Noise can be abated by using low-threshold laser diodes and as few of them as feasible, i.e., by letting one such laser diode feed as many elements of the antenna array as possible. Figures 2; references 4.

UDC 621.372.8:523.9

Sensitivity Thresholds of UHF-Discharge Recording Systems in Waveguides

917K0073H Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 67-69

[Article by V. V. Denisenko, Ye. Ya. Kuzovlev, N. D. Nasledov, and A. V. Popov]

[Abstract] An experimental study concerning protection of high-power waveguide channels against breakdown by UHF discharges was made, two methods of recording such discharges being compared with respect to their sensitivity thresholds in terms of minimum detectable discharge intensity. The optical recording system picked up light emitted by discharges, with an FDL-118 avalanche diode in an amplifier channel as photodetector. Here breakdown was indicated by the optical signal exceeding a given threshold level. The wave recording system picked up microwave pulses, the sensing element here being the resistive probe of an instrument transducer with an amplifier for measurement of pulsed microwave power. In this case breakdown was indicated by attenuation, within one pulse duration, of the envelope of a wave passing through the waveguide. The two systems were simultaneously tested simultaneously with pulsed rather than continuous microwave power microwave power so as to avoid overheating the discharge device and at the same time trigger many discharges for adequate statistics, pulses of 45 μs duration being applied at a repetition rate of 100 Hz. The envelope of a wave passing through the waveguide and the optical signals from the discharges were recorded on oscillograms, while the numbers of discharge recording events per minute by each system were simultaneously counted by two frequency meters. Discharges occurred sporadically, their number during a test period varying from a few to several hundred. The experimental data have been evaluated by taking into account that the sensitivity thresholds of both systems were limited by noise in the amplifier rather than by noise in the photodetector or microwave sensor. Both systems were found to be equally sensitive to arc discharges inside a waveguide, but the optical system to be more sensitive to spark discharges at the waveguide flanges. Figures 3; tables 1; references 3.

UDC 621.391.029.7

Fabrication of Biconical Fiber-Optic Bifurcators With Laser Heater

917K0073I Moscow RADIOTEKHNIKA in Russian No 9, Sep 90 pp 88-90

[Article by A. V. Yazydzhi]

[Abstract] Use of a laser heater for fabrication of biconical fiber-optic bifurcators is considered, a typical such 2x2 bifurcator consisting of two optical fibers loosely twisted around each other. Heating of the both quartz glass cores produces surface tension which brings them into into close contact and their subsequent elongation in the hot state produces a biconical neck along which energy redistribution between the two channels will then take place. The operating principle of a single-mode fiber-optic bifurcator is based the waveguide coupling of the two cores through the part of the electromagnetic field which exponentially decays while it propagates beyond a core toward its sheath. Operation of a multimode fiber-optic bifurcator involves sequential elimination of radiation modes propagating along each fiber from its core into its sheath within the converging "input" cone, where modes are cut off, sheath modes then continuing to propagate along the common sheath of the two fused channels and energy redistribution occurring within the diverging "output" cone. The heater must be designed so that it will produce the required neck geometry and bifurcator performance characteristics, with means of controlling the temperature profile the heat-affected zone. On the basis of preliminary test results, a 10.6 μm CO_2-laser has been selected as heat source in preference to a CO-laser, an electric arc, and a oxyhydrogen flame. Accordingly, two LG-23 (ILGN-705) single-mode CO_2-lasers with a total power of 10 W were used experimentally for fusion of two optical fibers into a bifurcator, both fibers being placed inside a cylindrical reflector on its axis in the spot of intersection of the two Gaussian laser beams and heated to a temperature slightly above the 1200°C softening point. The two lasers were mounted so as to emit parallel beams, a spherical mirror controlling the intensity of one beam and deflecting it onto the axis of the cylindrical reflector for intersection with the other beam. This mirror was a concave one with an about 1 m radius of curvature for a 7-8 W laser (LG-23) beam, but should be a convex one with a 2.0-0.5 m radius of curvature for laser beams with 15 W or higher power. The results confirm theoretical estimates indicating that this method, much simpler than the conventional ones, will also yield graded-index fiber-optic bifurcators with an insertion loss smaller than 2 dB and with a (1:1)+/-10 percent division of radiation power between the channels. Figures 3; references 9.

Principles of Constructing Comprehensive System for Computer-Aided Design of Railroad Automation and Remote Control

917K0057 Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ in Russian No 10, Oct 90 pp 8-10

[Article by V. V. Sapozhnikov, doctor of technical sciences, professor, M. N. Vasilenko, candidate of technical sciences, docent, and S. P. Bakalov, scientific associate, Leningrad Institute of Railroad Engineers, D. S. Markov, candidate of technical sciences, director, and V. G. Trokhov, candidate of technical sciences, docent, "Automation and Remote Control Systems" laboratory]

[Abstract] The concept of a comprehensive system for computer-aided design of railroad automation and remote control is developed which meets three requirements: continuity of the design cycle, complete coordination of design facilities, and universality of software. The software covers all three categories of objects: station, track span, and classification yards. It consists of four divisions: interactive programming of design objectives, expert appraisal system of basic simulation models, reference library, and and interactive programming of design procedures. The simulation models in the expert appraisal system cover automation of relay-contactor and functional logic in addition to stations, track spans, and classification yards, thus facilitating complete comprehensive comparative technical and cost analysis of various alternative automation systems, verification and correction of engineering calculations to adjust to changing service conditions, quality control of problem solutions at any stage of the design procedure, building up standard data arrays, and safety analysis of train movements. Figures 2.

Ways to Develop Main Primary Communication Network for USSR Ministry of Railroads

917K0057B Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ in Russian No 10, Oct 90 pp 16-17

[Article by A. V. Demchuk, candidate of technical sciences, senior scientific associate, Wire Communication laboratory, All-Union Scientific Research Institute of Railroad Automation]

[Abstract] Conversion of the main railroad communication system from an "each station network to central network" one into a primary "each station to each other station" one is considered and the obstacles to making this conversion by conventional methods impossible are analyzed. The main obstacle is limited capacity of the existing K-16 data transmission lines, which also serve as telephone communication carriers, so that multiplexing them will create a conflict between capacity and reliability requirements. To this must be added the question of economics in face of a steadily expanding railroad system. Conventional approaches to solution of this problem have not been effective and, therefore, new concepts are called for. It is proposed that installation of K-1920 communication lines, which have a larger capacity, proceed along with flexible integration of all autonomous departmental networks and with use of not only primary but also secondary or tertiary interstation connections depending on the specific requirements. A scheme of combining upper-level with intermediate-level and lower-level departmental networks is shown, implementation of such a scheme requiring revision of the present USSR Unified Automatic Communication System and thus intervention of the government. Figures 1.

UDC 621.396:625.151

Apparatus for Radio Control of Turnouts From Locomotive Cabin

917K0057C Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ in Russian No 10, Oct 90 pp 20-24

[Article by B. N. Pichugin, radio mechanic, Intersectoral Industrial Railroad Transportation Enterprise, Klin]

[Abstract] The radio control apparatus ARUSP-K is designed for control of turnouts and crossing signals from the locomotive cabin by a coded signal, such a signal being generated by a railroad radio control transmitter inside that cabin with the antenna mounted on top. A rail switch is driven by a d.c. electric motor. A transformer box next to the motor contains a transformer and an FM radio control receiver station (70RTTs-2-FM "Dnepr") connected to a 2-phase or 3-phase or 3-phase traffic light, its antenna being mounted on top of the light post. A rectifier stack of semiconductor diodes in a separate box is connected across the two rails. A traffic light is also manually controllable by push-button. The locomotive radio control transmitter station includes four autonomous audio-frequency oscillators (520-850-1260-1760 Hz) and four triggers, safety being ensured by eliminating the possibility of simultaneous control from another locomotive. With four different audio frequencies one can generate six two- frequency codes and thus control 12 traffic arrows, inasmuch as the same code turns a traffic arrow both ways. With five different audio frequencies one could generate 10 two-frequency codes and control 20 traffic arrows. The codes are adequately immune to interference and manual control is almost error-free. A programmer with necessary logic has been designed which can also generate three-frequency codes. The control time is 7-9 s. The radio receiver station is supplied from a 17 V a.c. source and draws a power of 8-10 W when operating in the control mode. It is suitable for around-the-clock duty at temperatures from -35°C to +35°C. Figures 1; tables 2.

UDC 656.25:621.316.9

Electrically Safe Splicing of Communication and Signalization- Centralization-Blocking Cables along A.C. Electric Railroad Lines

917K0057D Moscow AVTOMATIKA, TELEMEKHANIKA I SVYAZ in Russian No 10, Oct 90 pp 37-38

[Article by E. Ye. Ass, candidate of technical sciences, director of laboratory, and V. M. Sokhor,candidate of technical sciences, senior scientific associate, All-Union Scientific Research Institute of Transportation Facilities Construction, N. S. Shilling, chief engineer, "Transss-vyazstroy" (Transportation Communication Construction) Trust]

[Abstract] A clamp with appropriate grounding has been developed for splicing underground communication and signalization-centralization-blocking cables. It is a rod with four circumferential grooves into which up to four insulated cable wires are individually laid. From one end of this rod projects a lateral tab for holding the clamp in position and at its other end the rod is pinned to a rotating arm. A cap is slipped on that arm and fastened to it with two set screws. Four pins in a row are inserted into the arm through holes in the at cap so that they will fit into the four grooves in the rod and will press on the cable wires in them as the arm is rotated into the closing position. The pins can be pulled out and replaced when worn or broken. The rod is also pinned to a conductor which has a cross-sectional area of at least 0.75 mm^2 and terminates into a grounding clip. A pair of such clamps, one on each of the two cable segments to be joined, can be used for safe splicing with equalization of electric potentials by means of a wire mesh. After the tips of all cable wires have been stripped of insulation, the clamps are fitted on insulated wires of the two cable segments 40-50 mm behind the free bare tips. The last step of the procedure is checking all electrical connections. Gloves made of a dielectric material must be worn throughout the splicing process and can be taken off for subsequent operations. Figures 2.

UDC 681.586.33:681.515"312""313"

State Scientific Research Institute of Heat Power Instrument-Making: Its Present and Future

917K0093A Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 90 pp 2-4

[Article by G. G. Iordan, NIIteplopribor]

[Abstract] The achievements of the State Scientific Research Institute of Heat Power Instrument-Making (NIIteplopribor), a base organization of the State Interbranch Association for the Development and Production of Process Control and Monitoring Instruments (MGO Prompribor), since its inception fifty years ago are summarized. In recent years the institute has widely utilized microprocessor technology to develop various automated control systems, such as multitask process controllers (Remikont), programmable logic multitask controllers (Lomikont), dialog display controllers (Dimikont), and controllers and regulators for a smaller number of tasks. State-of-the-art pressure, flow rate, and level gauges produced by the institute are described. New methods and designs being developed by the institute are aimed at insuring its long-term competitiveness in western markets. NIIteplopribor's hardware includes YeS 1045 systems as well as the British Apricot computers and IBM PC' while its software base includes the Dragon system developed by Quest (U.K.) and Prosystem, PCAD, and AUTOCAD from Austria. High-precision testing and graduation instruments and other microelectronic devices produced by the institute are described. In 1989 the institute employed 2,050 people and its production volume reached 142.9 million rubles. Figures 1.

UDC 681.52

Remikont R-130: A New Control System

917K0093B Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 90 pp 5-9

[Article by G. G. Iordan, N. M. Kurnosov, V. V. Pevzner]

[Abstract] Distributed process control methods being used at the State Scientific Research Institute of Heat Power Instrument-Making (NIIteplopribor) and changes brought about by the onset of integrated circuits are summarized. Microprocessor-based regulator-controllers (Remikont), logic controllers (Lomikont), and dialog display controllers (Dimikont) developed in cooperation with the Cheboksary Industrial Automation Special Design Office and aimed at automating relatively large plants are described. A new concept embodied in the new Remikont R-130 developed for smaller installations is analyzed. The R-130 has a modular design which makes it possible to assemble control systems of varying degrees of complexity. The R-130 is an all-purpose device and can be used within a broad range of processes; its functional capabilities exceed those of most similar systems. Specific components, functional capabilities, virtual design, on-line control, configuration, and network architecture of the R-130 are described in detail; a number of future developments aimed at expanding its capabilities is considered. References 2; figures 5; tables 2.

UDC 681.513.2:658.51.011.56

The Remikont R-130 Microprocessor Controller for Regulation and Programmable Logic Control

917K0093C Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 90 pp 9-11

[Article by Ye. A. Yakhin, A. V. Khasin]

[Abstract] New logic design features of the R-130 Remikont multichannel microprocessor-based controller which make the interface more user-friendly and expand the controller's functional capabilities are discussed. The R-130 combines the advantages of analog devices and computers but is free of their shortcomings. Two R-130 models developed by the State Scientific Research Institute of Heat Power Instrument-Making (NIIteplopribor) together with the Cheboksary Industrial Automation Special Design Office are described. General data and details of programming, on-line control, library of algorithms, transient conditions, and network architecture are summarized. Plans for developing computer-driven Remikont controllers are described. References 4: 2 Russian, 2 Western.

UDC 681.515.004:658.51.011.56

Automated Setting Algorithm for the Remikont R-130 Microprocessor Controller

917K0093D Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 90 pp 14-17

[Article by V. Ya. Rotach, V. F. Kuzishchin, M. V. Fishbeyn]

[Abstract] A method for automatically adjusting the control circuits of proportional integral derivative (PID) controllers used in the Remikont R-130 microprocessor controllers is described. The method is compared to other automated adjustment methods. The proposed method employs a two-step relay and a phase-shifting filter with an interactive optimum search algorithm. The design makes it possible to use a self-correcting optimum search procedure, takes into account real characteristics of the controller being adjusted, and employs strictly formalized optimal adjustment criteria. It is emphasized that the algorithm under consideration is only one of many possible adjustment algorithms; it is relatively simple and makes it possible to optimize the controller's adjustment parameters independently of each other. Moreover, the system cannot lose stability regardless of the initial controller setting parameters. The algorithm's

disadvantage is in its relatively poor noise immunity and the possibility of parameter estimation errors under strong perturbations affecting the entity during the adjustment. References 6: 3 Russian, 3 Western; figures 3.

UDC 681.2.08

Certain Features of Developing High-Pressure Semiconductor Strain Transducers

917K0093E Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 90 pp 23-25

[Article by A. V. Beloglazov, V. I. Yevdokimov, Ye. B. Kotlyarevskaya]

[Abstract] Distributions of sensitivity and temperature coefficient of resistance of silicon resistance strain gauges placed on the face surface of membrane-type strain transducers are examined as a function of the resistor's geometric factor. A high-pressure strain-sensitive circuit and strain gauge design are developed. The results of an examination of strain transducer characteristics under lab and operating conditions at pressures of up to 500 MPa are presented. The strain transducer's operating principle is described and compared to that of foreign pressure gauges. As a result of the study the transducer sensitivity was increased by 20-30 percent while the systematic component of the zero value temperature error was reduced three-to-fivefold without increasing the nonlinearity error. The limit of transducer applications due to its ultimate strength is examined. References 12: 9 Russian, 3 Western; figures 3; tables 1.

UDC 681.2.08

New Complex of the Sapfir-22M Unified Pickups

917K0093F Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 90 pp 27-30

[Article by G. G. Iordan, A. Ya. Yurovskiy, A. G. Smirnov, V. I. Serdyukov]

[Abstract] The results of studies aimed at attaining higher pickup accuracy and reliability, decreasing the effect of such destabilizing factors as temperature and static pressure, and increasing the instrument's immunity to *g*-loads are summarized. A new complex of transducers with an expanded measurement range is considered and their principal specifications are cited. Forty-five different models making up the modernized Sapfir-22M complex are described. Principal designs of base transducer models are presented and their electrical parameters are listed. As a result of the studies, the transducers' technical characteristics were upgraded, the electronic conversion design was modernized, the reliability of sensor protection from failure or irreversible deformation was improved, the effect of destabilizing factors was decreased by a factor of 1.5-2, and metrological characteristics were improved. References 6; figures 3; tables 2.

UDC 531.781.2:621.315

Modernized Resistance Strain Gauge Transducers for the Sapfir-22M Pickups

917K0093G Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 90 pp 30-32

[Article by V. I. Yevdokimov, G. I. Lurye, V. I. Sukhanov, A. V. Beloglazov]

[Abstract] Principal characteristics of pressure and strain gauge transducers intended for use in modernized Sapfir-22M pickups are presented. The transducers were modernized in order to decrease their parameter spread and improve the time stability of their characteristics without altering their overall and mounting dimensions. After the improvements the transducer design remained essentially the same. The stability of S05M transducers was examined at the NIIteplopribor while the stability of D2.5M pickups was analyzed at the All-Union Scientific Research Institute of Physical and Electrical Engineering Measurements (VNIIFTRI). The transducers are characterized by their high output signal level at the maximum operating load. Experimental studies show that the real strain distribution on the elastic element surface of all types of transducers differs from that obtained in calculations using a classical mathematical model. This fact was taken into account in designing modernized strain gauge circuits. References 9; figures 2; tables 1.

UDC 681.121

Acoustic Gas Flow Rate Meter

917K0093H Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 11, Nov 90 pp 35-36

[Article by G. V. Gromov, Z. I. Nazarenko, O. A. Pankova, I. D. Shelaputin]

[Abstract] The problem of measuring the flow rate of corrosive gaseous substances is addressed. The development of a gas flow rate meter based on the contactless acoustic measurement method is described. In implementing the method, the difference in the propagation times of acoustic vibrations from the emitter to the detector in opposite directions at an angle to the flow motion direction of the medium under study is determined. Phase, pulse time, and pulse frequency methods of measuring the time lag are described. The studies show that under the existing sonic pulse propagation conditions in the controlled medium, the time discrimination method is the most suitable; it makes it possible automatically to track relatively slow changes in the time position of periodically recurring pulse signals. Specifications of an acoustic gaseous flow rate meter are cited. References 2; tables 1.

New Image Intensifiers With Improved Characteristics

917K0072A Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 90 p 20

[Abstract] Four new modifications of PMU image intensifiers have been developed, PMU251/252 with a 25 mm screen and PMU 401/402 with a 40 mm screen. All employ the four-electrode scheme with microchannel plates, a V-configuration of microchannel plates in the PMU 252/402 units making it possible to register individual photoelectrons. Each has a built-in field- emission electron source for electronic degassing of the microchannel plates and each includes a distortion corrector. The precision components are made of a cermet material. The modifications were devised by V.M. Zhilkina, V.N. Syrtsev, and G.G. Feldman; Figures 1; tables 1.

Small Infrared Lasers, Receivers, and Components for Laser Technology

917K0072B Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 90 p 21

[Abstract] There are now available custom-built small infrared lasers and receivers, also their components, all featuring a high interference immunity. The pulsed 4.3-12 μm CO_2-lasers cover wide ranges of pulse energy (0.1-10 J), pulse duration (0.03-3 μs), and repetition rate (0.1-10 Hz). They can operate with frequency doubling and mode locking, in a ring laser set and in a hybrid set with a continuous-wave CO_2- laser, with isotopes, and with intracavity wavelength tuning as pump source for submillimetric lasers. They weigh 3-30 kg. The pulsed neodymium, tunable over the 0.53-1.35 μm range, cover wide ranges of pulse energy (0.05-5 J) and pulse duration (0.01-1000 μs). They can operate in the free-emission mode, with passive or active mode locking, and in the continuous-wave mode delivering a power up to 10 W. The modulators of CO_2-laser radiation are available in low-voltage ratings up to 10 V, with a transmittance ranging from about 0.95 maximum to below 0.01 minimum. The infrared receivers with nitrogen cooling or helium cooling, with preamplifier and synchronous detector optionally included in the cryostat, cover the following ranges of the spectrum: 2-6 μm, 4-14 μm, 8-26 μm, 20-120 μm, 100-4000 μm. The infrared receivers without cooling cover the 4-12 μm range of the spectrum with a sensitivity up to 1 V/W and a response time of about 1 ns. Available active media include Gd-Sc-Ga:Nd, Gd-Sc-Ga:Cr,Nd, Gd-Ga:Nd garnets, and garnets doped with other elements. Refills for small tubes of continuous-wave CO_2-lasers are also available, including refills containing C and O isotopes.

UDC 621.374.3

High-Speed Converter of Time Intervals

917K0072C Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 90 pp 105-106

[Article by T. M. Demyanchuk, A. V. Biyenko, and M. D. Prokopiv]

[Abstract] A new time-interval-to-code converter has been developed employing conventional high-speed pulse counters but featuring a higher resolution. It consist of a reference-pulse generator, two D-triggers with a latch each, three AND gates, one NOT gate, and one OR gate. Its components are built with series K500LM105 and K500TM130 microcircuit chips. With reference-pulse repetition period of 10 ns, the converter can encode time intervals of 10 ns to 10 ms duration in real time. Figures 3; references 5.

UDC 621.373.5

Solid-State Microwave Oscillator With Automatic Frequency Control

917K0072D Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 90 pp 118-119

[Article by N. V. Volkov and G. S. Patrin, Institute of Physics, Siberian Department, USSR Academy of Sciences, Krasnoyarsk]

[Abstract] The authors have developed and built an 8 mm microwave Gunn oscillator with a gyromagnetic converter for use with magnetic-resonance spectrometers. The converter is a weakly ferromagnetic and strongly anisotropic $FeBO_3$ single crystal. Both the Gunn diode and the converter crystal are mounted inside a segment of a standard rectangular waveguide open at one end with a flange and closed at the other end by a movable short-circuiting plunger. The diode is in a fixed position, between the open end and the movable converter crystal attached to the plunger head through a bilaterally metallized piezoceramic spacer plate. A thin film of epoxy without hardener between the spacer plate and the quartz mount enhances buildup of longitudinal strains. The waveguide segment is placed in the air gap between the two poles of an electromagnet, the latter then being moved along with the plunger so as to keep the converter crystal all the time in the external magnetizing field. A signal of about 80 kHz from a low-frequency oscillator excites the piezoceramic spacer plate into resonance. The microwave oscillator can be tuned mechanically over the 30-35 GHz range by movement of the plunger. With an $FeBO_3$ crystal of appropriate quality and dimensions, and with the plunger in the appropriate position, it can be tuned magnetically over the 0.8-1 GHz range. Both oscillator and electromagnet fit into a 140x60x80 mm^3 large housing. Figures 1; references 4.

UDC 621.373.5

High-Power High-Frequency Magnetic Thyristor-Type Pulse Generator

917K0072E Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 90 pp 119-122

[Article by P. G. Gordeyev, A. A. Kalinov, N. P. Polyakov, V. V. Sinenko, P. P. Rumyantsev, and Yu. P.

Yarushkin, Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] A magnetic thyristor-type pulse generator has been designed and built for pumping Cu-vapor lasers. It delivers bipolar 20-25 kV voltage pulses of 20-25 kV of 100 ns or shorter duration to a capacitive load of 3.3 nF at repetition rates up to 10 kHz and with an average power of 10 kW. It consists of a pulse transformer and an inverter bridge with two thyristors in series in each arm. Each of these eight thyristors is shunted by a 23 KΩ resistor in parallel with a 11 Ω resistor and a 0.027 gmF - 1000 V capacitor in series. The primary of the pulse transformer is, in series with a 3.3 μF charging capacitor and a saturable choke, connected across one port of the inverter bridge. The secondary of the pulse transformer is connected across the load through a pulse compressing Π-ladder network of 3.3 nF shunt capacitors and series saturable chokes. The pulse voltage is regulated by the pulse-width method, with a diode across the other port of the inverter bridge and a thyristor in series. This thyristor is preceded by a saturable choke identical to that in series with the transformer primary and is followed by a linear one. Both chokes together reduce the rate of voltage rise dV/dt across all thyristors, while the saturable one in series with the transformer primary reduces the post-switching overvoltages across them. The two saturable chokes have each a 14 turns of wire wound on a core of 79HM permalloy tape. The efficiency of this pulse generator is 64 percent. Figures 3; references 6.

UDC 621.316.933

Individual Controllable Discharger for Capacitors With Coaxial Leads

917K0072G Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 90 pp 135-138

[Article by N.K. Kapishnikov, Scientific Research Institute of High Voltages at Tomsk Polytechnic Institute]

[Abstract] A controllable thyratron-type discharger has been designed and built for reliable individual charging of noninductive capacitors with coaxial leads in up to 4 kJ high-power capacitive energy storages, with minimum variation of the firing time and with adequately high breakdown voltage. Its discharge tube is made of acrylic glass protected by a conical brass cup inside around the discharge gap against contamination by electrode erosion products and thermal breakdown by hot gas during high-current discharge. It is filled with an inert gas, preferably krypton on account of its highest electric strength. The two main disk electrodes made of elconite and 4-5 mm in diameter are separated by an adjustable gap. The high-voltage electrode is connected directly to the center lead of the capacitor, which passes through a sealed hole into the tube. The low-voltage electrode is connected to the capacitor through radio-frequency cable segments, one to six of them depending on the required inductance of the capacitor discharge circuit. The control electrode, an elconite rod, passes through a center hole in the low-voltage disk electrode. The discharger was first tested with commercial nitrogen under pressures of 0.3-0.6 MPa. Its excellent behavior during the firing period was offset by wide variation of the uncontrolled-breakdown voltage and by degradation of electrophysical characteristics owing to dissociation of nitrogen during the subsequent discharge period. It was then tested with a Kr + N_{26} mixture and a 7 mm long main interelectrode gap (uncontrolled-breakdown voltage ≈ 90 kV). A nanosecond long firing stability was maintained at operating voltages from 35 to 50 kV. The very low low rate of electrode erosion indicates that the main electrodes could be made of M1 copper or electrical-grade graphite rather than of scarce elconite. This has been confirmed experimentally. With steel electrodes (St3 plain carbon steel), however, the discharger became uncontrollable after about 200 firing and discharge cycles, evidently owing to their appreciable erosion and to chipping of the elconite control electrode. Figures 1; references 9.

UDC 621.382

Pulse Shapers Built With Superhigh-Speed GaAs Integrated Circuits

917K0072F Moscow PRIBORY I TEKHNIKA EKSPERIMENTA in Russian No 5, Sep-Oct 90 pp 122-125

[Article by V. I. Mogilin, V. Yu. Smerdov, and A. I. Khlybov, Moscow Institute of Energetics, Smolensk branch]

[Abstract] A shaper of subnanosecond pulses has been built using GaAs integrated-circuit logic gates on a 6500LR1 microcircuit chip. The characteristics of this microcircuit are: logic 0 ≤ 0.1, logic 1 ≤ 1.5 V, average signal time delay mF 250-420 ps, maximum operating frequency ≈ 1 GHz, supply voltages V_{cc1}= +4 V and V_{cc2}= -2.4 V. The pulse shaper has two AND gates with a coaxial input lead to one and a common coaxial ouput lead. It can be followed by a voltage amplifier stage on two n-channel field-effect transistors (AP602A and AP602G). With delayed negative feedback to one gate through a resistor and two coaxial cable segments, it will operate as a controllable self-sustained pulse generator. With an adjustable 0-15 V d.c voltage supply connected through an LC-filter to one gate, on a 6500LR2 chip, it will operate as a pulse shaper with continuous pulse duration control. The pulse shaper on a 6500LR2 chip followed by a TR-trigger on a 6500TT1 chip with a delay line between them will put out pulse pairs with wide regulation of the time interval between them, either continuous regulation by means of a varicap or discrete regulation by changing the capacitor size in the delay line. Figures 2; references 3.

UDC 681.586:629.76

Transducers Apparatus in Rocket and Space Technology

917K0070A Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 p 4

[Article by Yu.P. Semenov, corresponding member, USSR Academy of Sciences, chief engineer]

[Abstract] Development of rocket and space technology cannot proceed without adequate means of flight data acquisition by measurement with instruments on board and on ground. An essential component of the measuring system are transducers, which need to be perfected in terms of reliability and accuracy so that the number of costly test vehicles and the testing effort can be minimized. A transducer for this application must therefore satisfy special requirements, considering that the relatively small and simple looking device is in reality a very complex one with a sensing element capable of operation under extremely severe conditions. These include not only a wide range of constant temperatures and wide temperature swings but also large linear accelerations, shocks and vibrations, acoustic noise, and aggressive chemical action of surrounding media. In addition to high immunity and stability, such a device must have minimum mass and draw minimum electric power when converting physical quantities into electric signals. It must retain sufficient mechanical strength wherever it is installed so as to outlive the test object under extremely heavy mechanical loads in an anomalous environment and retain its accuracy and reliability over long periods of time, considering that probes and rockets now remain in space for years and even decades. Further progress in rocket and space technology will, therefore, depend largely on further development of measurement methods and apparatus including transducers.

UDC 531.7.084.2

Trends in Development of Special-Purpose Transducers

917K0070B Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 pp 4-6

[Article by Ye.A. Semenov, candidate of technical sciences, deputy director for scientific activity, Scientific Research Institute of Physical Measurements]

[Abstract] The fact that special-purpose transducers and especially those for the aero-space industry must satisfy stringent requirements so as to qualify for operation under extremely severe conditions has stimulated a great deal of research, as a result of which several generations of pressure, force, strain, and displacement transducers, tachometers, and accelerometers have been developed by the Institute of Physical Measurements and actually built over the past three decades. One can discern certain trends in their development, a major one being preferential use of semiconductor and especially silicon devices on account of their relatively low cost as well as their small size, high reliability, versatility, and easy integration of sensing elements with intermediate signal converter stages. The compatibility of thin-film and thick-film semiconductor devices complementing one another makes it possible to combine them for optimum overall performance and maximum cost effectiveness. This trend is attended by a departure from design of conventional structures and a transition to design of microstructures on the basis of microelectronic technology using crystalline and amorphous materials. There are also other new types of devices available which find increasing use for special-purpose transducers: devices employing plane surface acoustic waves, fiber optics, magnetic and nonferrous metallic thin-film devices, dielectric and piezoceramic thin-film devices. There is now a great need for much longer service life and shelf life, also for more reliable methods of accelerated testing as an important cost saving measure. Future scientific and technical research activity at the Institute will be concerned mainly with redesign of 1) pressure transducers (resistive and capacitive ones for measurement of static, dynamic, and especially fast-varying pressures), 2) displacement transducers (inductive, transformer, eddy-current, and especially Hall-effect transducers for measurement of small radial and axial displacements), the aim being to satisfy the requirements of new special applications by adoption of the new technologies. References 3.

UDC 621.586.326'772

Capacitive Absolute Pressure Transducers

917K0070C Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 pp 6-8

[Article by D. V. Lebedev, candidate of technical sciences, V. V. Selifanova, engineer, G. N. Razudalova, engineer, A. A. Shoshin, engineer, and A. I. Russkikh, engineer]

[Abstract] Theoretical and experimental studies have resulted in a development of high-precision capacitive absolute pressure transducers on the basis of microelectronic technology. Considering that nonplanarity of the sensing element rather than thermal expansion of structural materials is principally responsible for the poor metrological characteristics of conventional capacitive transducers, the resulting error has been minimized by construction of a secondary transducer with autocompensation in the measuring circuit and with balancing of instantaneous charge levels. The contribution of the edge effect, mainly to the additive component but also to the multiplicative component of the conversion error, has been minimized by shielding. These features are incorporated in the design of three capacitive quasi-differential pressure transducers with a thin-film MDM structure. Adequate shielding against the edge effect has

been achieved by minimizing the thickness of the dielectric layer and by connecting the metal electrode to be shielded to the inverting input of an operational amplifier with strong negative feedback so as to equalize the potential of this electrode with the frame potential. The sensing element of both the YePD-6 transducer and the DSYe-001 transducer is a membrane with a rigid center. The sensing element of the DSYe-097 transducer consists of two membranes with rigid centers on a coupling stem. All three perform nominally well in a normal climate, the YePD-6 and the DSYe-001 also adequately at temperatures from +20° up to +200°C and down to -196°C and the DSYe-097 at temperatures from +20° to +300°C. All three can withstand 10-4000 Hz vibrations with an acceleration amplitude increasing linearly from 1 g to 400 g. The best of them is the YePD-6, with an additive error component of approximately 0.00025%/°C over the 0-400° temperature range when not compensated and with a multiplicative error determined principally by changes in the modulus of elasticity of the sensor material. Those changes can be minimized by using an alloy such as 29Ni-26Co-Cr'Ti'Nb'Al',W'C'Si'-22 in the new elinvar group. Figures 1; tables 5; references 4.

UDC 531.78.084.2

Piezoresistive Pressure Transducers

917K0070D Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 pp 8-9

[Article by A.V. Sablin, candidate of technical sciences]

[Abstract] A series of miniature pressure transducers with integrated membrane-type strain gages has been developed at the Scientific Research Institute of Physical Measurement on the basis of silicon diffusion layer technology for high-sensitivity measurement of static and dynamic pressures, the latter covering a wide frequency range of shock wave and pulse pressures. They are the DDE 060 and the DDE 084 for measuring shock wave pressures of 0.5-2.8 MPa gage and 4-60 MPa gage within the 0-10 kHz frequency range respectively, the DDE 085 for measuring shock wave pressures of 1-60 MPa gage, the DDE 073 and the DDE 074 for measuring aerogasdynamic pressures of 0.045-1.4 MPa within the 0-0.5 kHz or the 0-1.5 kHz frequency range, the high-speed DDE 081 and DDE 082 for measuring aerogasdynamic pressures of 0.022-4.0 MPa within the 4-20 kHz (DDE 082) frequency range, and the DDE 095 for measuring contact pressures of 1-22 MPa. The largest one (DDE 060) is 53 mm long and 27.7 mm in diameter. The already commercially produced DDE 060/073/074 transducers are operational at temperatures from -40°C or -50°C to +50°C, the soon to be produced DDE 081/082/084/085/095 transducers will be operational at temperatures from -90°C to +100°C. Figures 3; references 5.

UDC 681.586.34

Acoustic Pressure Transducers

917K0070E Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 pp 13-14

[Article by P. G. Mikhaylov, engineer, V. I. Butov, engineer, I. P. Vinokurov, engineer, and I. I. Kuzmich, engineer]

[Abstract] A series of acoustic pressure transducers has been developed at the Scientific Research Institute of Physical Measurements for measuring acoustic pressures of 85-198 dB within the 0-80 kHz frequency range under severe conditions. They include the LKh 610 and the DKhS 512/513/514/515/ 516/517/520 piezoelectric transducers and the DKhP 096 piezoresistive one. Their novel features include a temperature compensating gasket which ensures constant pressure on the piezoceramic sensor, an elastic element made of silicon with a staircase profile designed to optimize the transducer performance, stress concentrators induced in the silicon crystal by anisotropic plasmochemical etching, a semiconductor film between the silicon crystal and the glass base ensuring that the two are electrostatically coupled. The effect of vibrations on the piezoelectric transducers is minimized by means of compensating piezoceramic elements in a push-pull arrangement with the operating ones. Use of a piezoceramic sensor material with a high Curie point minimizes temperature-related measurement errors. The effect of vibrations on the piezoresistive transducer is minimized by minimizing the mass of the semiconductor-type sensor. An aluminum thin-film shield on the nonplanar side of the silicon crystal and a metal mesh connected by cable to the metal case immunize the performance of the piezoresistive transducer against interference from strong optical and electromagnetic pulses. For their certification, all these transducers are tested in an air jet inside a shock tube under high high-frequency acoustic pressure, above 150 dB and 10 kHz respectively, while their amplitude- frequency characteristics are measured with a digital spectrum analyzer. It is noteworthy that DKhS 516 and DKhS 517 transducers were successfully used in development and flight testing of the multiple-use "Energiya" (Energy) rocket and "Buran" (Storm) spacecraft. They are being commercially produced, as is also the DKhS 512. While production of DKhS 513/514/515 and DKhP 096 transducers is still in the experimental stage, only a prototype of the DKhS 520 has been built so far. Figures 2; tables 1; references 3.

UDC 531.714.2.084.2

Scanning Transformer-Type Displacement Transducers

917K0070F Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 pp 15-17

[Article by A. N. Trofimov, candidate of technical sciences, and V. I. Bychenkov, engineer]

[Abstract] Two series of small high-precision displacement transducers have been developed, both of the rotating transformer type with magnetically coupled four coils of the excitation winding and four coils of the readout winding. Transducers of the first series consist of a hollow cylindrical outer stator core which carries both windings in circumferential slots and a cylindrical inner rotor core on a shaft between two ball bearings. The stator has also axial teeth and the rotor has teeth cut all at the same skew angle, the two sets of uniformly spaced teeth facing each other across the cylindrical air gap. Transducers of the second series consist of a stator disk core and a rotor disk core facing each other. The stator core carries both windings in several concentric circular slots split by four radial slots 90° apart so that four quadrants are formed with one sectoral pancake coil of each winding in each. The rotor disk has an Archimedean spiral slot facing the stator slots across the radial planar air gap and is mounted on a shaft between two ball bearings which also passes through a much wider center hole in the stator disk.. This shaft has an extension beyond the bearing in the end shield behind the rotor and nests in a capped bearing inside the transducer housing behind the stator disk. The basic angular displacement transducers are the cylindrical PUI 060 of the first series and the PUI 047 (PUI 060 with a step-up gear set), the latter with nine measuring ranges 0-0.14,...,0-6.0 rad. The basic linear displacement transducers are the PLI 063 and the PLI 027E, each structurally an angular displacement transducer coupled to a step-down worm-gear set, with eight measuring ranges 0-30,...,0-700 mm and with six measuring ranges 0-8 mm,..., 0-45 mm respectively. The overall dimensions of the PUI 047 are: length 48 mm and diameter 34 mm. The overall dimensions of the PLI 063 are: length 45 mm and diameter 45 mm. Three other transducers with special kinematic schemes including a linear-to-angular displacement converter drum are: 1) PLI 029E for measuring linear displacements up to 1 m, 2),3) PLI 030E and PLI 055 for measuring linear displacements larger than 1 m. The output signal of each transducer is converted into a parallel binary code. All transducers are operational at temperatures from -60°C to +200°C. Figures 6; tables 1; references 3.

UDC 531.714.2.084.2

Optoelectronic Linear Displacement Transducers

917K0070G Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 p 19

[Article by Yu.A. Lapshov, engineer, and T.I. Murashkina, engineer]

[Abstract] Optoelectronic linear displacement transducers can be almost universally used for contactless measurement of linear displacements in the direction of their axis, their readout being proportional to the phase difference between transmitted and reflected signals. The light beam coming from a light source and modulated by a sinusoidal signal from an oscillator impinges on a mirror mounted on the moving object which reflects it onto a set of operating photodetectors, except a part of it which has been diverted to impinge directly on a set of compensating photodetectors. That electric output signal of a compensating photodetector passes through an amplitude scaler and then a phase shifter which linearize it before it is added to the output signal of an operating photodetector in a summing device. The phase of the sum signal is the transducer readout, measured with a phase meter. The transducer readout depends not only on the phase difference between the two signals bt also on the ratio of their amplitudes. A change in the light intensity or fluctuation of the supply voltage will not results in an additional error, inasmuch the two amplitudes with change proportionally and their ratio will thus remain unchanged. The standard series of PLO 064 transducers developed and already in the experimental production stage at the Scientific Research Institute of Physical Measurements, for operation with the FOTON-1L intermediate converter or a standard F2-34 phase difference meter, has a measuring range of 0-90 mm within the 0-30 Hz frequency range of linear oscillations with accelerations up to 150 m/s^2. They are 65.6 mm long and 48 mm in diameter. They are operational at temperatures from -50°C to +60°C and can withstand vibrations with accelerations up 20 m/s^2 and shocks with accelerations up to 1500 m/s^2 acceleration. Figures 1; tables 1; references 1.

UDC 531.768

Direct-Acting Low-Frequency Linear Accelerometers

917K0070H Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 pp 19-21

[Article by N.V. Marova, engineer, N.S. Meshkov, engineer, M.V. Tyurin, engineer, V.I. Gorodnov, engineer, and G.D. Khokhlova, engineer]

[Abstract] A comparative survey of direct-acting low-frequency linear accelerometers covers basic design and performance characteristics of conventional ones and of a new generation. The commercially produced conventional ones are: Vt 45 and ALI 030 with differential-inductive sensing elements, Vt 51 series (96 variants) with differential-transformer sensing elements. The new generation of smaller and better ones are: ALE 027 (+/-11—+/-4000 m/s^2) with a piezoresistive sensing element now produced experimentally as well as ALYe 035 (+/-11—+/-1400 m/s^2) with a variable-gap differential-capacitive sensing element and ALE 033 (+/-3000—+/-100,000 m/s^2) with a crystal mounted between glass plates as sensing element (12 modifications) to be ready for production in 1994. The new accelerometers are designed for production with intense use of microelectronic technology. Figures 7; tables 1.

UDC 531.768.082.14

Compensated Low-Frequency Linear Accelerometers

917K0070I Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 10, Oct 90 pp 21-22

[Article by V.V. Metalnikov, engineer, A.N. Lyubeznov, engineer, V.N. Kolganov, engineer, A.A. Papko, engineer, Yu.M. Malkin, engineer, and A.V. Kulichkov, engineer]

[Abstract] Five new low-frequency linear accelerometers have already been developed and one is being developed. The basic VT 43 (+/-0.18—+/-1400 m/s^2) contains an operating differential capacitive displacement transducer and a compensating differential magnetoelectric reverse transducer on a beryllium membrane suspension, its distinguishing feature being the separate damping channel formed by windings of the reverse transducer and an amplifier. It operates with a 9-channel power supply module and a control module. The more precise and smaller Vt 48 (+/-0.18—+/-700 m/s^2) is a better designed and assembled version, with a preamplifier and a phase-sensing demodulator behind the 8-65 Hz low-pass filter. It operates with a 10-channel power supply module and a control module. The basic photooptical accelerometer Vt 49 (+/-0.011—+/-11 m/s^2) has an elastic element made of very stable quartz glass and low- expansion alloys. It operates with the Vt 43 9-channel power supply module the Vt 48 control module. The high-sensitivity photooptical ALO 034 (+/-0.011—+/-5.6 m/s^2) is structurally analogous to the Vt 49, except for a quartz suspension and a built-in power supply. The capacitive accelerometer ALYe 032 (+/-0.18—+/-700 m/s^2) features a sensing element made of a precision alloy and fused quarts on a pendulum suspension, with an only 20-30 gmm wide initial operating gap so that a sensitivity of 10^6 V/m and gaseous damping as effective as liquid damping become feasible. The micromechanical version of this accelerometer is to be produced with intense use of microelectronic technology: anisotropic etching, electrostatic welding, and ion implantation. Figures 3; tables 1.

UDC 621.3.019:681.325.3

Built-In Tolerance Inspection of Digital Displacement Transducers for Latent Parametric Failures

917K0061A Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 90 pp 11-12

[Article by N. Ye. Konyukhov and G. I. Leonovich]

[Abstract] Built-in inspection of digital linear-displacement and angular-displacement transducers for latent failures of either the electromechanical primary processing component or the electronic secondary processing component is considered as an important part of reliability and performance assurance. Latent failures are demonstrated in an optoelectronic digital angular-displacement transducer where optical input signals are code-modulated by a disk on the rotating shaft and then converted into proportional electric signals by a discharge-type photodetector array. Two codes are formed in the electronic part of the transducer, one for rough angle readout being formed by a square-pulse generator and one for fine angle readout being formed by amplitude interpolation in an analog-to- digital converter. A separate auxiliary photodetector puts out signals which, converted into square pulses, remove the ambiguity from the fine-readout code in a subtracting device. Together, both codes indicate the true shaft rotation angle. Latent parametric failures are due to not readily detectable flaws which lower the reliability of the output code to below the tolerable level in the absence of obvious failure indicators. In the electromechanical part such flaws are a shift, a twist, and a bend of the shaft, a shift, a twist, and a bend of the code disk, a chipped or dirty code disk, axial and radial play in the guide bearings, photodetector degradation and failure. In the electronic part such flaws are faulty circuit elements and circuit connections, instability of supply voltages, faulty supply leads and communication lines. Timely removal of transducers with latency to failure from service can be facilitated by building into them a set of tolerance monitoring devices with data output and display. The performance of such devices is evaluated in terms of probability of failure-free transducer operation as well as for accuracy in both continuous and periodic inspection modes. Figures 2; references 9.

UDC 621.314.252:681.142.37

Phase-Type Displacement Transducers Using Multielement Photodetector

917K0061B Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 90 pp 13-14

[Article by A. V. Kosinskiy, V. R. Matveyevskiy, A. Ye. Popov, V. B. Bogdanovich, and Yu. V. Ushenin]

[Abstract] An improvement in the design of displacement transducers with a phase grating and specifically of the optoelectronic interpolator type is proposed which will simplify the optomechanical part, namely using a multielement photodetector array: a grid of busbars surrounding photoresistive sensor pads in a specific configuration on an insulator substrate. Each element of this photodetector array receives light which has passed from a common source through a diaphragm above that element and has been modulated by displacement of the object. Two photodetector elements are assigned to each modulation channel and the diaphragms act as light probes. Their geometrical dimensions and the spatial configuration of all ensures that the two of each pair have matching electrical resistances: equal constant components and equal amplitudes of oppositely alternating

components. The photodetector array receives also signals coming from a carrier-frequency oscillator through a phase shifter. The photodetector output signals pass through a parallel array of readout devices to a summing device, the latter putting out a signal whose amplitude is constant and whose phase depends linearly on the displacement of the object. For an analysis of the formation of the modulating signal (envelope signal) in any of these displacement-to-amplitude conversion channels, there is introduced a periodic function of the space phase which describes the edge of the photosensor passband in the given system of coordinates. A further design and performance analysis indicates ways in which such a transducer can be optimized. Figures 2; references 5.

UDC 681.2.08:621.385.2

Apparatus for Measurement and Display of Radiation Pattern of Light Emitting-Diodes

917K0061C Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 90 pp 33-34

[Article by A. A. Yedreyev, N. I. Shumilova, G. N. Zakharova, A. A. Vilisov, and P. V. Vershinin]

[Abstract] An apparatus for measurement and display of the radiation pattern of light-emitting diodes has been assembled into two channels, a measurement channel with a photometer and a graphic display channel with an XY-potentiometer on a planchet. Both channels are controlled by an Elektronika-60 M microcomputer and are interfaced with a CAMAC crate. The microcomputer peripherals include magnetic disk memories, an alphanumeric display panel, and an alphanumeric printer. The crate contains an ATsP-12 analog-to-digital converter, a current stabilizer, a potentiometer drive, and a crate monitor. The test equipment can be set for diode currents ranging from 50 mA to 1.5 A in 10 mA steps. The light flux from a diode is picked up by 37 photodetectors (photodiodes) spaced around a 120° circular arc, 2° apart within the 40° central sector and 5° apart within the two 40° lateral sectors. Figures 1; references 4.

UDC 543.42.001.4

Problems Pertaining to Testing and Inspection of Spectrum Analyzers

917K0061E Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 90 pp 45-46

[Article by Yu. F. Pavlenko, S. I. Slavinskiy, and N. P. Sokolovskiy]

[Abstract] Adequate testing and inspection of radio-frequency spectrum analyzers poses several major problems, considering that these are generally multipurpose instruments which cover a gamut of frequencies as wide as from ELF to SHF. The five main problems are establishment of an interrelation between analyzer characteristics and signal characteristics in terms of relevant physical units, standardization of measurements covering a given spectral range, formulation of an adequately accurate model of the test signal, development of effective methods of measuring the analyzer performance parameters, and development of hardware for implementation of these methods. The analyzer performance is described by a set of frequency parameters, a set of amplitude parameters, and a set of distortion parameters. Determination of the frequency parameters involves frequency and/or time interval measurements. Methods of determining the amplitude parameters are direct voltage or power measurement, conversion of a parameter into voltage or power, conversion of a parameter into modulation factor when using an AM test signal or into frequency deviation when using an FM test signal, "constant input" or "constant output" method, and use of compound test signals. Determination of nonlinear distortions involves use of spectrally pure test signals and measurement of the output ripple factor. An overall solution to the analyzer testing and inspection problems based on these requirements will be separate normalization of all analyzer parameters characterizing a linear noninductive four-pole device and all parameters characterizing the deviation of a real analyzer from this ideal one. Involving a linear model subject to Ohm's law facilitates the selection of signals, but requires estimation of the resulting systematic error and stipulation of the analyzer characteristics in the test circuit. No spectrum compression is, moreover, permissible in the case of compound test signals whether pulsed or modulated ones. Absence of dynamic distortions will be ensured by appropriate selection of passband, sweep time, and detector time constant. Building special frequency and voltage gages into spectrum analyzers will cut down testing and inspection effort, inasmuch as such gages need to be inspected much less often. Figures 1; references 2.

UDC 621.317.361.088

Methodological Basis for Design of Precise Oscillation Sources and Means to Ensure Their Metrological Reliability

917K0061F Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 90 pp 47-48

[Article by A. S. Kleyman]

[Abstract] Considering that commercially produced high-frequency and microwave radio oscillators with a quartz frequency stabilizer do not satisfy latest precision requirements, their instability being of the order of 10^{-5} percent and their parasitic frequency deviation being accompanied by high phase noise, a methodological basis is formulated for producing such oscillators and also means to ensure their metrological reliability. Measurement of frequencies and frequency characteristics is standardized by use of a frequency synthesizer system consisting of several cophasal tunable oscillators. A

typical such system includes a reference oscillator followed by three successive oscillator stages with three separate feedback loops for phase-lock automatic frequency control. Each stage consists of a frequency multiplier followed by a mixer with two outputs and an oscillator behind one of them, a tunable i-f oscillator in each of the first two stages and a stabilizing oscillator in the third stage. Behind the second output of each mixer is an i-f amplifier feeding a phase detector. Each phase detector receives not only the respective i-f signal but also the output signal of a frequency synthesizer, each frequency synthesizers receiving its input signal from the common reference oscillator. Each oscillator in the successive three stages receives a feedback signal from the respective phase detector, after this signal has passed through a low-pass filter and then a d.c. amplifier. The first i-f oscillator is, according to this scheme, included in all three loops. A performance analysis of such an oscillation source entails evaluating the spectral power density of phase fluctuations in the output signal and in the corresponding reference oscillation. The optimum design of a high-stability oscillation source on the basis of such a scheme will evidently involve optimizing the tradeoff between the signal-to-noise ratios pertaining to two principal performance parameters, namely the spectral power density of phase fluctuations and the frequency instability best characterized by the Allan dispersion. The frequency instability is generally measured over periods of time ranging from 100 μs to 1000 s. Errors in determination of the frequency instability, especially the short-time one associated with "dead time", have been eliminated in an apparatus which measures it over a 1 s period and also the spectral power density of phase fluctuations at 1 kHz frequency with resolution of 185 dB/Hz. Figures 1; tables 2. references 6.

UDC 543.42:389.1

Metrological Characteristics of Automatic Sequential Spectrum Analyzers

917K0061G Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 90 pp 48-50

[Article by G. A. Goncharov and A. M. Kudryavtsev]

[Abstract] The performance of the three fourth-generation spectrum analyzers SK4-83/84/85 with automatic control by microprocessor, all three multipurpose instruments, is analyzed for accuracy. All heterodyne oscillators in each of these instruments have been designed according to the "coherent synthesis" scheme with connection to a quartz reference oscillator under thermostatic control. The error of measurement of the third and last intermediate frequency in the SK4-84 spectrum analyzer is calculated, for illustration, this one containing three heterodyne stages. The frequency of a converted signal falling within the third intermediate band is measured here with a built-in frequency which has been locked into synchronism by the reference oscillator. Automatic calibration is initiated by push-button and involves a sequence of seven steps: 1) application of a calibrating reference-level input signal and search for the maximum value of the analyzer response signal; 2) tuning of the receiver stage to the following oscillator by variation of the frequency of its reference oscillator, with concurrent measurement of the drift of the i-f filter's center frequency; 3) calibration of both input and i-f attenuators at the center frequency, 4) calibration of the logarithmic amplifier at the center frequency; 5) calibration of the instrument's amplitude-frequency characteristic with a special gage over the given sweep range; 6) measurement of the effective noise passband of the filter; 7) setting the overall instrument gain at the center frequency of the given sweep range for the reference-level calibrating signal. The amplitude-frequency characteristic of the instrument is determined by the input attenuator, the wideband amplifier, the low-pass filter, and the first mixer. The principal error of reference-level signal measurement is caused by nonuniformity of instrument's amplitude-frequency characteristics and, inasmuch as a calibrator of this characteristic is not included in the SK4-85 spectrum analyzer, means of preliminary recording and storage of amplitude-frequency data have been provided for automatic access to them during subsequent measurements. Figures 2.

UDC 534.647:681.2.089

Performance Requirements and Design Guide for Standard Seismometer

917K0061D Moscow IZMERITELNAYA TEKHNIKA in Russian No 9, Sep 90 pp 34-38

[V. N. Nekrasov]

[Abstract] A survey of 16 seismometers, including three made in the U.S. (HS-10-1, TG 20171, TG 36000-01) and one made in Germany (FS-60), indicates that none of them is adequate for use as a standard instrument covering all frequency ranges of earthquakes. Inasmuch as there is a need for development of such an instrument, the performance requirements are defined and the design principles are formulated for that purpose. The standard must have a flat amplitude-frequency characteristic covering the 0.01-100 Hz range, 95% of the frequency range within which all measurements are made. Its sensitivity and dynamic range must be not worse than that of any instrument now in use, namely 10^{-8} m.s^{-2} maximum and 120 dB minimum. Its operating characteristics must match those of a low-frequency electromechanical systems, which most instruments now in use are, with minimum size and weight under all those constraints. As the most promising instrument satisfying these requirement is deemed to be one having the structure of an accelerometer in high-frequency high-Q gimbals and using a piezoelectric or capacitive transducer with negative feedback. The feasibility of producing such an instrument has been demonstrated experimentally with a piezoelectric bimorph cell. Figures 2.

UDC 621.317.365

High-Speed Instrument for Measuring Wavelength of Laser Radiation

917K0041A Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 90 pp 38-39

[Article by V. I. Bobrik, A. Yu. Grachev, and S. I. Kraval]

[Abstract] An instrument is described which measures the wavelength of laser radiation in each emission pulse at repetition rates up to 1 kHz. The instrument includes an optical lead-in fiber and a telescope mirror followed by three channels consisting each of a beam splitter, an interferometer, a photodetector array, and a photodetector control. A channel commutator passes the photodetector output signals sequentially through an analog-to-digital converter and a monitor for processing by a central computer. The key components are the three interferometers, Fizeau interferometers with approximately 3 mm long bases, which can measure radiation wavelengths within up to 0.02 nm wide emission lines. The photodetectors are charge-coupled arrays. The monitor, a microprogrammable 16-digit processor performing $7x10^6$ operations per second, controls the readout of interference patterns and locates interference fringes while the photodetectors are being completely scanned within 1 ms each at a clock pulse repetition rate of 1 MHz. The instrument was tested on an Ar^+-laser, with an LGN-302 He-Ne laser as reference laser for determination of an integer interference order. Figures 1; references 2.

UDC 621.317.757:681.2

Present Status of Instrumentation for Real-Time Signal Analysis

917K0041B Moscow IZMERITELNAYA TEKHNIKA in Russian No 8, Aug 90 pp 50-52

[Article by B. A. Chuprakov and I. P. Krasnoshchekov]

[Abstract] Currently available instrumentation for real-time signal analysis is surveyed, specifically multiprocessor computing devices which process signals digitally by the method of fast Fourier transformation with the maximum operating frequency ranging from below 1 kHz (simplest low-cost models) to 2 MHz (most elaborate special-purpose models). The upper cutoff frequency ranges correspondingly from 20 kHz to 10 MHz. The dynamic range is usually 70 dB with a 12-digit A/D converter or 90-96 dB with a 16-digit A/D converter. More than 50 models are now on the market, the leading manufacturers being Ono Sokki, Hewlett-Packard, Bruel & Kjaer, Solartron, and "Intertechnique". They can be classified into portable single-channel or two-channel ones with both own battery and cord to a.c. power line, single-channel ones for measuring only intrinsic characteristic of signals, two-channel ones with two synchronous input channels for measuring intrinsic and collective characteristics of signals, and multichannel ones with basically eight-16 but possibly 64-512 input channels. Tables 2; references 23.

UDC 537.8.001.24

Modeling Two-Dimensional Electromagnetic Fields in Electromechanical Devices With Moving Parts by Method of Finite Elements

917K0075A Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA No 9, Sep 90 pp 28-34

[Article by Yuriy Nikolayevich Vaskovskiy, candidate of technical sciences, senior scientific associate, and Larisa Nikolayevna Dynnik, engineer, Institute of Electrodynamics, UkSSR Academy of Sciences, Kiev]

[Abstract] One difficulty in modeling electromagnetic fields in electromechanical devices with moving parts by the method of finite elements is that their motion makes the differential equations less manageable. Although numerical solution of these equations by this method is feasible, the convection term $\sigma\bar{v}$ X (del X A) ($\bar{v}$- velocity vector, A- magnetic vector potential, σ- electrical conductivity) in the equation for the magnetic potential A introduces an asymmetry into the matrix of the determinant system of algebraic equations. One way to retain symmetry and thus facilitate the modeling process is to transfer the convection term to the right-hand side of this equation and then solve the latter by iterations. This is demonstrated on a two-dimensional electromagnetic field with a magnetic vector potential which has only one component in, say, a Cartesian system of coordinates. Another difficulty in modeling electromagnetic fields in electric machines by this method arises directly from the relative motion of parts. Depending on the degree of complexity and the specific features of the problem, the grid of finite elements within the calculation domain remains unchanged, becomes deformed in time, or must eventually be replaced with a new one. In some cases it may be possible, by selection of the appropriate system of coordinates, to not only prevent deformation of the grid but also avoid changes in the material properties of all parts within the calculation domain. This is demonstrated on two examples: 1) inductor, a ferromagnetic plate (length L= 0.06 mm, thickness t= 0.005 mm) carrying a multiturn winding with a direct current (1.72 A/mm^2), in the middle of a 0.015 m wide air gap between two half-space metal structures (electrical conductivity σ= 58 MS, magnetic permeability $\mu_0 = 4\pi 10^{-7}$ H/m) one of which moves relative to the inductor at a constant velocity of 250 m/s while the other remains stationary; 2) electric motor consisting of a wound stator and a smooth solid rotor. Calculations were made for several instants of time within a 0-0.4 ms and 0-30 ms period respectively. Grids of triangular first-order finite elements were used and, as the grid kept deforming, their areas were altered not more than three times so as to avoid constructing a new one. The size of grid zones covering active materials needs to remain unchanged during calculations so that the law of energy conservation not be violated and the boundaries of the calculation domain need to be sufficiently far away from the targeted active region of the machine so as to minimize the influence of edge effects on the finite-elements model. Figures 2; references 4.

UDC 621.313

Giant Magnetostriction: New Possibilities for Building Electric High- Torque Precision Motors and Drives

917K0075B Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: ELEKTROMEKHANIKA in Russian No 9, Sep 90 pp 34-41

[Article by Sergey Ivanovich Frolov, candidate of technical sciences, scientific associate, Moscow Institute of Energetics]

[Abstract] A general description of plain magnetostriction and related effects in ferromagnetic materials, namely piezomagnetism, magnetoelasticity, spontaneous magnetostriction, and mechanostriction, as a reference for comparison, giant magnetostriction in rare-earth metals (Sm,Dy,Ho,Er,Tb) and their compounds with iron (RFe_2) not only at low but also room temperature is described in detail and evaluated on the basis of experimental data available since its discovery in 1961 (K.P. Belov, R.Z. Levitin, S.A. Nikitin). As a practical application of this effect are considered electric microdisplacement torque motors built with piezoelectric crystals (quartz, Rochelle salt), piezoelectric ceramics (barium titanate, lead titanate-zirconate), or magnetostrictive materials (nickel, permendur, 65Co-35Fe alloy, 14Al-86Fe alloy, grade-21 sintered-powder ferrite, intermetallic compounds). The data reveal the superiority of those intermetallic R-Fe compounds in terms of high electromechanical energy density and magnetostriction saturation, higher than that piezoceramics, their drawback being a low mechanical strength and particularly low impact strength. Magnetostrictive motors have a frequency bandwidth of only 0-30 Hz and should, therefore, operate under static or quasi-static conditions. Their appreciable hysteresis under compression is comparable with that of piezoelectric transducers. Inasmuch as the magnetic field is much stronger in magnetostrictive motors with giant magnetostriction than in motors with plain magnetostriction, and requires more energy to be produced, they are most advantageously used for pulse duty at room temperature and for continuous duty with cryogenic cooling only. Figures 9; tables 6; references 20.

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Electromagnetic Terminal Servomechanisms and Their Optimization for Industrial Robots

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[Article by Mikhail Abramovich Lyubchik, doctor of technical sciences, professor, Kharkov Polytechnic Institute]

[Abstract] The design of electromagnets for four different industrial robot servomechanisms is analyzed, all of them having a shell structure: 1) lifting gripper electromagnet with a magnetic core, a magnetizing coil, and a shunting disk across the air gap; 2) plunger electromagnet with the stop in a ferromagnetic shunting sleeve, length of shunt controllable by adjustment of stop position; 3) electromagnet in an elastic cylindrical yoke made of a ferroelastic material, designed for reciprocating motion of armature without mechanical return mechanism; 4) electromagnet with reliable "thrust pin and guide slot" transmission for reciprocating motion of the armature. Optimization of any such electromagnet is formulated as a multicriterial and multiparametric minimization or maximization problem of nonlinear programming for a set of dimensional and winding variables under constraints, in the form of equalities and inequalities, applicable to design of electromagnetic devices generally and to operation of automatic manipulators specifically. The method of geometric programming can be employed directly when the characteristics of the state of the system are describable in the form of polynomials, otherwise only after these characteristics have been approximated with polynomials by means of correcting functions. This is demonstrated on two variants of solving the problem for typically five design parameters: 1) basic three parameters are varied and two parameters with the most narrow ranges are fixed; 2) all five parameters are varied. Figures 2; references 3.

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